AMERICAN MACHINIST

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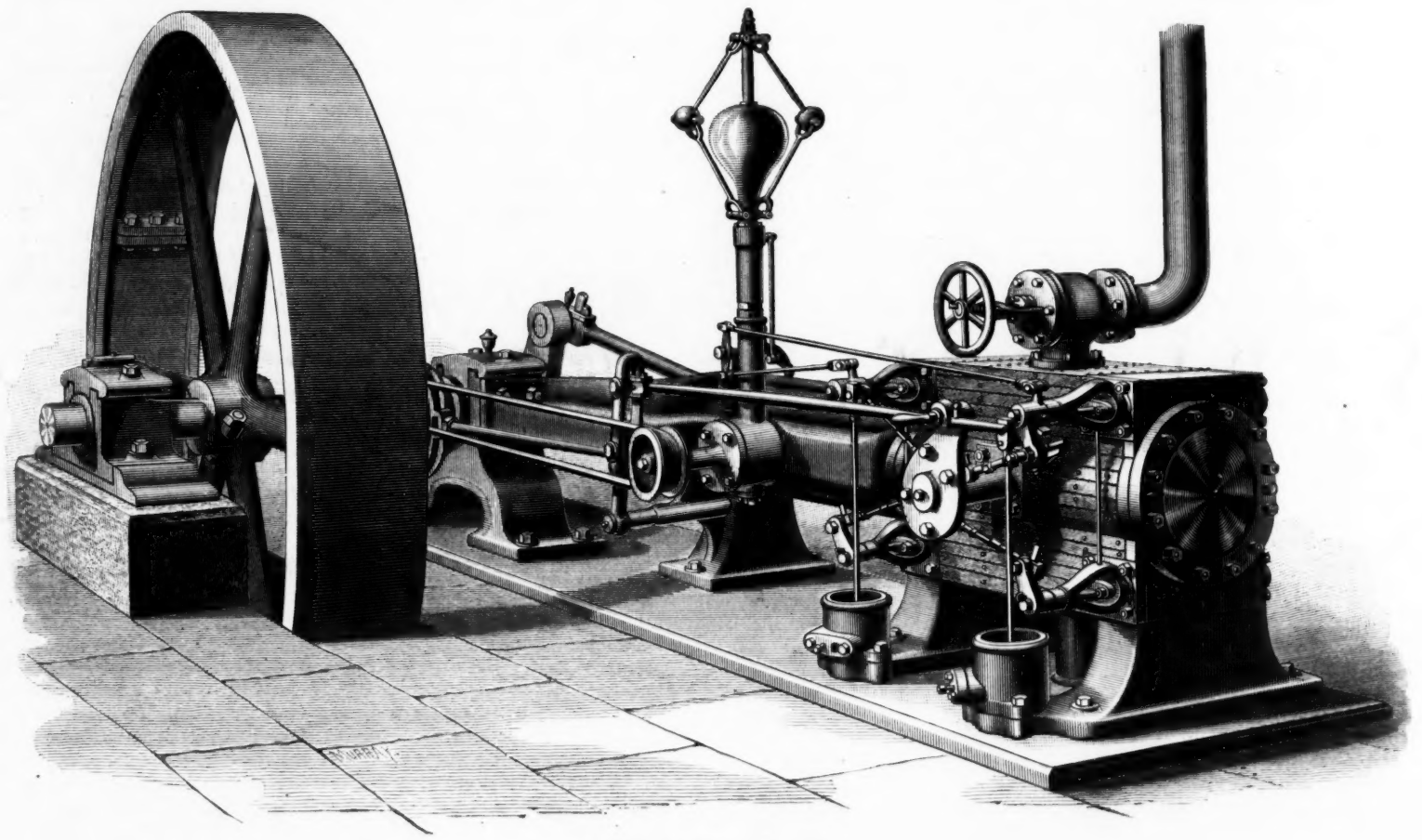
The McLaren Improved Corliss Engine.

The engraving represents a Corliss steam engine recently brought out by John McLaren, River street, Hoboken, N. J. These engines are very substantially built, and have all the improvements of this class of engine known to the builder. The general design is the same as that of any first-class Corliss engine. The notable features of these engines will be found in the bed-plate, rocker, eccentric rod connections, and governor. The bed-plate, which is a very heavy one, is enlarged at the cylinder end, and bolted to the cylinder in a manner which will bring these bolts inside of the bed-plate, thereby obtaining a large amount of room for packing the piston rod and screwing up its glands. The rocker journals are formed in the center bearing of the frame, and not simply bolted to the frame. The rocker arms may be termed double arms, because the pins to which the eccentric rod and parallel bar are connected do not project beyond the rocker arms, but are secured between the rocker arms; by this arrangement the eccentric rod and parallel bar are brought to the same distance from the center line of cylinder, and thus obtaining as near as possible a direct motion. The advantage of this arrangement must be apparent; projecting pins are avoided, and greater safety secured. The admission of steam is regulated by a Porter governor which has been adapted by Mr. McGowan to the Corliss engine; and, as will be seen in the illustration, the whole arrangement of the governor is a very simple one, giving it a clean and exceedingly neat appearance; also its construction is such which secures for it durability and a very sensitive action.

Four sizes of this design of engine are at present made, namely, 12″×30″ cylinders, crank shaft 6 inches in diameter; 14″×30″ cylinder, crank shaft 6½ inches in diameter; 16″×36″ cylinder, crank shaft 7½ inches in diameter; 20″×42″ cylinder, crank shaft 9½ inches in diameter.



IMPROVED CORLISS ENGINE.

An enterprising company, engaged in the business of accident insurance, has issued a new scheme of risks, in addition to the ordinary classification, by which they propose to indemnify their patrons in varying sums of money against loss of hands or feet, hand and foot, hand or foot, both eyes, one eye, and permanent total disability. Now, why wouldn't it be advisable to fix up by law some such table of damages, as proper to assess upon railroad corporations, and the makers and users of shoddy boilers, in cases where injuries of the above kinds are shown to be the natural and inevitable result of careless management or plain disregard of natural laws?

The ordinance compelling the use of smoke-preventing devices by factory owners who burn soft coal is being enforced in Minneapolis. Consumers of soft coal, not only in Minneapolis, but elsewhere, very generally claim that the smoke-preventing furnaces increased the coal consumption, and some tests have been made by Professor Pike and city officials of Minneapolis to determine the truth of this. It is claimed that these tests show no more coal burned with than without the smoke preventers.

Engineering and Mechanical Notes.

BY F. F. HEMENWAY.

V.

DETERMINING THE QUALITY OF STEAM.

(The following is mainly in the way of replies to questions on this subject, which replies would require more space than can be devoted to them in the regular department of "Questions and Answers.")

For all ordinary purposes we must know the quality of the steam furnished by a boiler before the efficiency of the boiler can be determined. It is possible that a large percentage of the heat in the fuel shall be transferred to the water in the boiler, and yet the efficiency be low. The pump may supply a certain quantity of water to the boiler, and this water may all pass out through the steam pipe; what we want to know is how much of it passes out as steam and how much as water.

Boilers are not infrequently credited with high duty, when, in fact, their duty is comparatively low. They get rid of the water that is supplied them, and it is assumed that it leaves in the condition of steam, when a liberal percentage of it passes out through the steam pipe in the form of water. It is almost always safe to say that unless a boiler is provided with superheating surface—and frequently even then—some water leaves it that has never been converted into steam. This water not only lacks the heat of vaporization which it would have as steam, but as steam—not water—is required, the heat that the water has taken with it is generally worse than wasted.

THE BARREL CALORIMETER.

The most common device for determining the quality of the steam furnished by a boiler is the barrel calorimeter; that is, a barrel is nearly filled with water into which a known weight of steam of a known pressure is injected. The quantity of heat in a pound of dry steam at different pressures and water at different temperatures being known, by observing how much the temperature of the water in the barrel is raised, the quality of the steam can be calculated. For convenience of expression, everything admitted to the barrel from the steam pipe is called steam, though it may be a mixture of steam and water.

OBJECTIONS TO THE BARREL CALORIMETER.

Strong objections have been raised against the use of the barrel calorimeter. These objections are that the results obtained by its use are contradictory, and hence without value. Mr. Charles E. Emery has pointed out the reason why these unsatisfactory results have obtained, as well as the remedy, for which engineers are much indebted.* By his permisssion I briefly summarize:

Steam should not be taken from the boiler, because if there is no circulation at the point from which it is taken, it would show dry in every event. It should not be taken from a perforated pipe crossing the steam pipe, as in that case it is likely to show superheating. It should be taken

* Trans. A. S. M. E., Vol. VI.

from a lateral opening in the steam pipe, the opening being from 1½ inches to 2 inches diameter. At about one foot from the main steam pipe, the pipe leading to the barrel should be reduced to ¾ inch or ½ inch diameter. Near the barrel this pipe should be provided with a valve, connected, by means of a coupling, with a rubber hose. In the coupling a metallic disk should be placed, the disk having a hole through it, from $\frac{5}{16}$ inch to ¼ inch diameter. A small propeller,* the blades made from sheet-iron, is used to agitate the water, these blades being fastened to the bottom of a vertical rod, the end of which runs in a wooden step at the bottom of the barrel, the rod being guided at the top of the barrel by means of a hole through a wooden cross-piece. The upper end of the rod is bent to form a handle.

It need hardly be observed that Mr. Emery's precautions are to the end of getting steam to the barrel of the same quality as that passing through the pipe, avoiding wire-drawing on the one hand, and on the other hand avoiding getting a disproportionate quantity of water.

HOW TO PROCEED.

The barrel is set upon platform scales, which, it hardly seems necessary to remark, should be placed as near as practicable to the boiler. The barrel is nearly filled with water—and the weight and temperature noted. To the weight of water is to be added a proportionate part of the weight of the iron in the propeller or paddle, that will be heated, this proportionate part being equal to the specific heat of the iron. The specific heat of iron is 0.113; multiplying the weight of iron exposed by 0.113 will give the weight to be added to the weight of the water. Thus if the weight of iron is 10 pounds the addition to be made to the weight of water in the barrel will be $10 \times 0.113 = 1.13$ pounds. It is advisable to make the weight of water in the barrel plus the addition to be made for the metal an even number of pounds, in order to simplify the calculation.

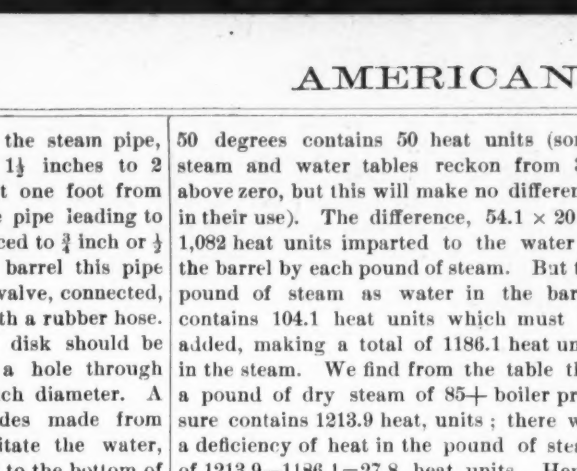
The barrel being filled and temperature and weight noted, the valve is opened and steam is blown through the hose into the atmosphere until the pipe is heated, when the hose is thrust into the barrel, the steam pressure being carefully observed, until the desired temperature — usually between 100° and 110° —is reached, the water in the meantime being thoroughly agitated. Then the hose is removed and the temperature and weight noted.

There will then be as data: The initial weight of water and the final weight as increased by the steam condensed, the original and final temperatures of the water in the barrel, and the steam pressure.

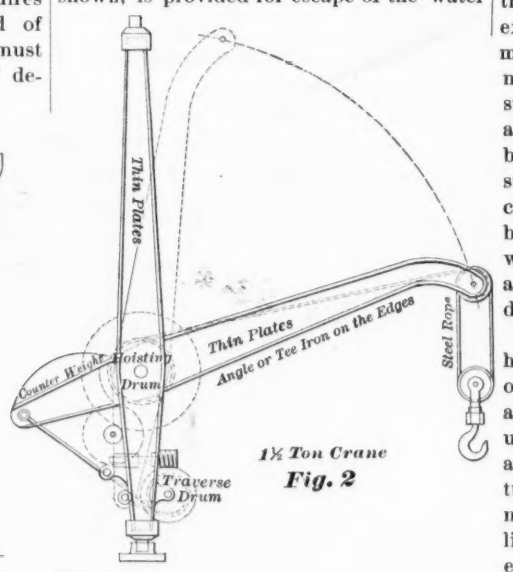
CALCULATING THE RESULT.

The necessary calculations can be made without the aid of algebraical formulas, to which engineers in charge of engines and boilers almost unanimously object. Assume, as a convenient example, that the weight of the cold water in the barrel, with the addition for the weight of metal as previously explained, is 300 pounds, and that 15 pounds of steam is added, making the final weight 315 pounds. Assume also that the temperature of the cold water—the initial temperature—is 50° and the final temperature 104°, and that the steam pressure is 100 pounds absolute, corresponding to a gauge pressure of 85+ pounds. Dividing 300 by 15 it is found that 20 pounds of water have been heated from 50° to 104° by one pound of steam. From tables of steam and water we find that one pound of water of a temperature of 104° contains, reckoning from zero, 104.1 heat units, and that the same water at 50 degrees contains 50 heat units (some steam and water tables reckon from 32° above zero, but this will make no difference in their use). The difference, $54.1 \times 20 = 1{,}082$ heat units imparted to the water in the barrel by each pound of steam. But the pound of steam as water in the barrel contains 104.1 heat units which must be added, making a total of 1186.1 heat units in the steam. We find from the table that a pound of dry steam of 85+ boiler pressure contains 1213.9 heat, units; there was a deficiency of heat in the pound of steam of 1213.9—1186.1=27.8 heat units. Hence we conclude that there was as much water in the pound of steam as would have been vaporized by 27.8 heat units. From the table we find the latent heat—heat of vaporization—of one pound of water at a temperature due to a steam pressure of 85+ pounds is 882.9 heat units. Dividing 27.8×882.9 gives .0315 pound, nearly, of water in every pound of what has been assumed to be steam. This is 3.15 per hundred pounds, or 3.15 per cent. of water. It is customary to call steam dry when the water present does not exceed 3½ per cent.

If it is found that there is more heat in the water than is accounted for by dry steam, then the conclusion is that the steam is superheated. We find the number of heat units that have gone to superheat the steam, by subtracting the heat units in the pound of steam as found in the table from the heat it has imparted to the water, the operation being as before, except that the relative positions of the numbers are, of course, changed in subtracting. For instance, in the example noted suppose it had been found that the pound of steam had contained 1220 heat units instead of 1186.1. Subtracting 1213.9 from 1220 leaves 6.1 heat units in excess of that contained in dry saturated steam. It requires .48 heat units to superheat a pound of steam one degree, hence the steam must have been superheated 6.1÷.48=12.7 degrees.



20 Ton Crane
Fig. 1



1½ Ton Crane
Fig. 2

HOFFMAN'S DESIGNS IN CRANES

In the foregoing calculations no attempt has been made to shorten the process; this can be done when it is fully comprehended.

It may be added that a great deal of care is necessary in using the barrel calorimeter. All instruments should be known to be correct, and observations should be made with the utmost exactness, as a very slight difference in quantities may make a large difference in the final figures.

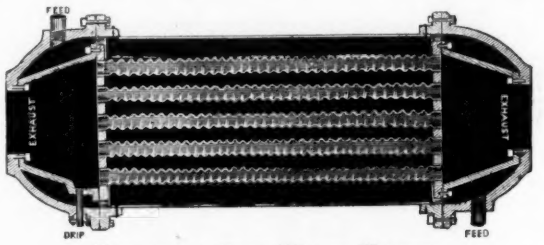
The initial temperature of the water in the barrel should be as low as practicable, and the quantity of water should not be less than 300—better 400—pounds. This for the purpose of reducing unavoidable errors to a minimum. For the same reason no more time than is necessary should be used in any of the operations.

One of the most interesting processes shown at the present American exhibition, Earl's Court, is the manufacture of lenses for spectacles and eye-glasses from Alaskan rock crystal. In this exhibit a rapidly rotating disc of hardened steel, ground to an edge and covered with diamond dust, cuts slices from the native crystal, each sufficiently large to make a lens. These slices are afterwards attached with pitch to an iron frame, in which a whole set are together ground to the same focal length.—*Engineering.*

The Wainwright Horizontal Feed-Water Heater.

The cut which we show with this represents the Wainwright Feed-Water Heater, adapted for use in a horizontal position, in which position it can be placed under the floor of the engine room, or where the head room is limited.

The special feature of these heaters is the use of corrugated copper tubes, through which the exhaust steam passes, imparting its heat to the water through the extended heating surface. It is claimed for these tubes that there is an increase of 50 per cent. in heating surface over plain tubes of the same length, while at the same time their strength is greatly increased, and, owing to their property of expansion and contraction, all danger of the ends pulling out or of the joints working and leaking is eliminated; also that the corrugations tend to keep the tubes free from scale.



HORIZONTAL FEED-WATER HEATER.

The feed water enters at the lower opening marked "Feed," fills the body of the heater, is heated and passes out at the upper opening marked "Feed," the exhaust opening being at ends. A drip pipe, as shown, is provided for escape of the water of condensation, and a hand-hole for washing and cleaning, not shown in cut.

It will be seen that this heater contains a large body of water well disposed to receive heat. It is made in sizes from 50 to 1,000 horse-power by the Wainwright Manufacturing Company, Boston, Mass.

Necessity the Mother of Invention.

It became necessary a short time since to change the gauge on a railroad in Utah from the narrow to the standard gauge for a distance of 250 miles. This change rendered necessary the adzing of every tie to the proper depth to place the two rails on an equal base. Heretofore in such work this preparation of the ties has always been done by hand-adzing, an army of men having to be employed at a large expense. Supt. Blickensderfer, of the road in question, thought that a machine could be devised that could be placed on wheels and driven slowly over the road to perform the work as it traveled, stopping for an instant over each tie. The idea was properly carried out, the machine constructed and the work done in 60 days at a cost of only about $2,000, which, by hand work, would have cost fully $15,000. The speed of the machine was from 1 to 2½ miles per hour. Of course, with a number of machines the time might have been greatly reduced. The chief features of the machine consist of a shaft made to revolve on a set of swing-hanger trucks, with a cutter three inches in diameter, having two steel knives or adzes of a length corresponding with the width of the cut to be made in the tie. To make a neat job, a saw is made to work at each end of the knives. The shaft is made to rise and fall the proper distance by an adjustable handscrew. The machine is so set that it can only cut to a certain depth, which is easily done, as the entire machine rests permanently upon the rails, the wheels always forming the desired base to which the cutters should be driven. In this machine the shaft was made to revolve 1,600 times per minute. It is believed that the machine can be so constructed as to be driven at a much higher speed than was employed in this first one. Such a machine will be of great value in making changes of gauge on roads. The machine is very simple and inexpensive in construction, and can be placed upon any ordinary railroad track.—*Mining and Scientific Press.*

Improved Methods of Handling Work in Foundries, Machine, Boiler and Blacksmith Shops.

BY W. H. HOFFMAN.

Thirty years ago the average apparatus for lifting and moving heavy castings, forgings and plates, was clumsy in design, slow in action, and limited in power. Steam was used in but very few shops, and the steam cranes of that date were not conveniently arranged, or safe for foundry service, as they could not readily be controlled to the extent necessary in hoisting large ladles of melted iron. Nearly all the steam cranes made previous to the year 1860 were of the stationary jib pattern, there being less than a dozen traverse cranes in the country, and but three or four of these were operated by steam, either directly or indirectly. The cranes for the machine, blacksmith and boiler shops were nearly all of the jib type, worked by hand, and all were limited in the amount of hoist, owing to the very faulty designs.

Any power crane for foundry use should have a liberal hoist, steady power, a change of speeds operated quickly by one operative, and a factor of 7 for strength in every detail under strain. If chains are used, the drums and pulleys over which they pass should be turned with accuracy, at the same time removing all sharp corners that are in anyway liable to come in contact with the chain, and every hoisting chain should be annealed at least once in two years.

Steel wire ropes are much the best for cranes, though some foundrymen object to the large pulley blocks necessary, but with properly designed cranes, any block of the sizes recommended by the wire rope makers can be used, and the writer has made them even larger than this without inconvenience. Ropes of $\frac{7}{16}$″, ½″, $\frac{9}{16}$″, ⅝″, $\frac{11}{16}$″ and ¾″ diameter, are the standard sizes for cranes, and the drums and pulley blocks run from 16″ to 42″ in diameter. For the sake of durability, a main hoisting drum should be covered with segments of close-grained, well-seasoned hard wood, and in this wood seating should be turned spiral grooves for leading the rope; by so doing the life of the rope will be very much prolonged.

All straps, links, clevices and hooks, should be made of the best mild American steel, American charcoal iron, or Swedish iron, well hammered to close up the metal, and then moderately annealed to counteract the crystallizing effects of the hammering. All shafts, pins and tension bolts, should have large round corners at the necks of journals, bolt heads, pins, etc. In these

* The writer has always used an iron ladle instead of the propeller; but the propeller is in the nature of being more complete and mechanical.

days of rolled beams and shapes, no crane should be made of wood, as the use of rolled metals will insure absolute safety, while the vertical space for hoisting can be very much increased over that possible with any wooden structure.

If jib cranes are desired (and these are the most convenient for some work) there are two types of them suited to a foundry, viz., the stationary jib crane, with traveling trolley or truck, and the movable or swinging jib generally hung on a hinge at the bottom of the post; the first named method is in general use, while the latter is designed for special work only.

In designing a crane with a stationary jib, channel iron or steel can be wholly used in the uprights, jibs and braces. Fig. 1, page 2, shows an economical way of distributing the metal, and the same is the case in the movable jib crane for light hoisting, say from 1,000 to 3,000 pounds, illustrated by sketch Fig. 2. The latter design was made by the writer some years ago for special standard work in a small foundry. It is made of thin plate iron, braced transversely by plain angle or T iron. The jib is moved by a worm and worm wheel, the ratio of leverage on the jib against the worm drum being about 2½ to 1, but in light hoisting this is not at all troublesome, and the crane, which can be built for very little money, is handled easily. When not in use these cranes occupy very little space, as the jib can be raised to a position nearly parallel to the main post.

Traverse cranes are now used in most of the large foundries, and some of them are well designed and very convenient in handling; in fact, this business is now a special one, as it should be, some builders having in their employ very competent engineers, who, of course, are familiar with the strength of all kinds of materials used in this class of construction.

One of the main objects in the design shown by the sketch of the 20-ton crane, Fig. 1, is to get as much hoist under the jib as possible, and, in designing a traverse crane, this important feature should not be forgotten. The top trolley blocks should be raised enough to allow the lower blocks to pass up through the main carriage and trolley frames, until the two are block and block; for by so doing a clear hoist of the whole distance up to the main traverse frame is obtained. All large traverse cranes, say from 5 to 50 tons' capacity, should be operated in all their movements by power. For foundry uses there are many opinions among foundry foremen as to the utility of the traverse crane, but I think the majority of competent foundrymen will agree in stating that any foundry large enough to melt 5 tons of iron per day should have a traverse crane of some kind, as well as the regular complement of good jib cranes.

If a foundry is 40 feet and upwards in width in the clear, and a traverse crane is to be used, I think the best economy can be reached by setting apart one end or a space in the center of the foundry for this purpose. I believe for a width of over 40 feet the space allotted to the traverse system should be divided by placing a girder so as to divide the width of the building, thus introducing two cranes instead of one; making one 25 feet, and the other 15 feet wide. By adopting this method both cranes can be used at the same time on different work, neither interfering with the other, and a traverse crane of 25 to 28 feet reach or span is large enough to meet all requirements, except, perhaps, those of ordnance and large marine foundries. The dividing girder should be a well-proportioned wrought-iron or steel one, supported by three columns of the same material resting on suitable piers of masonry, the tops of which should be about 9 feet below the foundry floor level, so that the piers will not be in the way of pit work.

I know of some traverse cranes having a span of over 50 feet, but at the same time I think if this span had been divided by using one crane 32 feet and the other 18 feet wide, the general work in such a foundry would be more easily handled than with a single traverser, and when a heavy piece is to be lifted and moved both cranes can be locked together and traversed as one.

For general machine shop use the traverse crane in any and all of its well-known useful forms is indispensable. In the erecting department there should be at least two traversers if the room is from 30 to 60 feet long, and if longer there should be three cranes, each one proportioned to raise at least 7 tons, and all of them so fitted as to be used jointly when needed, thus giving a combined capacity of 21 tons. The small automatic traverse cranes are very handy, but as I have already described them in a paper on "Special Tools," I will not dwell on this ingenious appliance here. Small jib cranes, like that shown in Fig. 2, can be well adapted to light hoisting in the machine shop, but as for large jib cranes for this department I think the space they occupy can generally be put to better uses. Small wall cranes have sometimes been used over vise benches, but the automatic traverse cranes have displaced them, as they do the work better and in half the time required by the old style.

The Waterhouse Dynamo and Arc Lamp.

The dynamo electric machine which we illustrate herewith represents the recent improvements made by the inventor, Mr. Waterhouse, with a view to securing increased rigidity, safer operation and higher efficiency. That, as well as the lamp shown, belongs to what is known as the Waterhouse system of electric lighting, controlled by the Waterhouse Electric and Manufacturing Company, Hartford, Conn.

The dynamo rests on an iron pan, which serves two purposes; first, in collecting any oil that may overflow from the oil recess, keeping the floor clean; second, it is provided with adjusting arrangements by means of which the dynamo can be moved for the purpose of increasing the tension of the belt should it become slack.

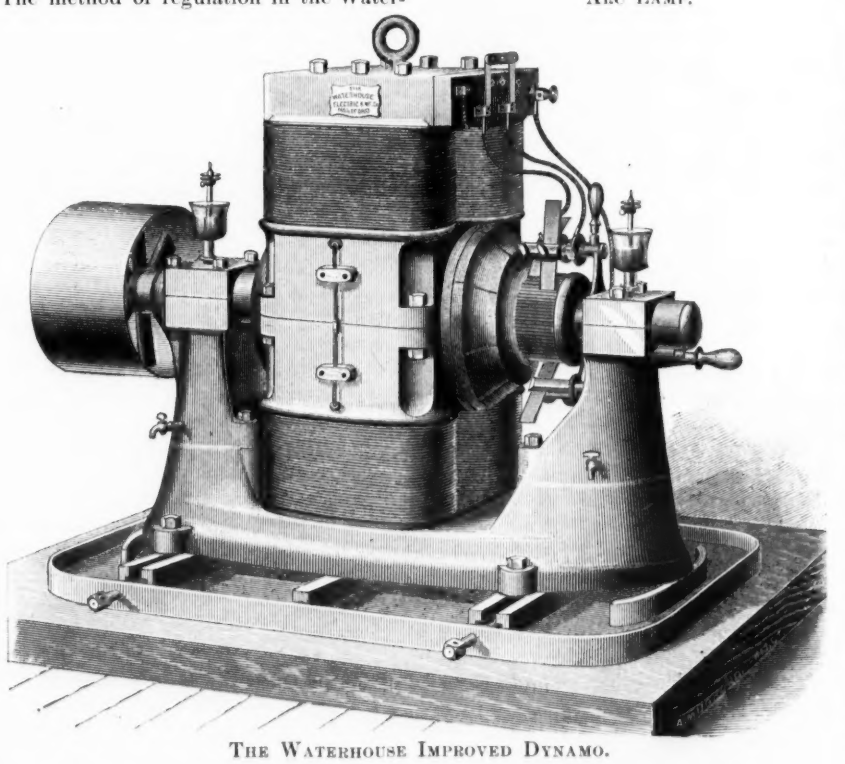
The stands are of pleasing form and of strong construction. They are provided with recesses for catching oil that drips from the journals and means for drawing off and saving this oil.

The method of regulation in the Waterhouse system is different from that usually employed. The brushes on the commutator have a fixed position at the maximum point for taking off the strongest current, and as no movement of them is necessary when cutting off lights, the machine is in condition to regulate instantaneously.

It is claimed for this system of lighting that there is a material saving by the closed circuit; that the buzz and sputter incident to long sparks has been done away with, and that practically the Waterhouse dynamos run without sparks or noise; also that the regulation is substantially perfect. The dynamo shown is known as the No. 3 machine.

The lamp illustrated is easy of adjustment, requiring only the turning of a nut to produce a long or short arc. It is made in three styles, viz., double carbons for all-night runs, single carbon with clutch feed, and single carbon with rack feed for eight hours' run. The same magnet is used in all, the arrangement being such that the changes in the flow of the current from the main to the shunt conductors on the magnet produce a gradual motion instead of a sudden and impulsive one. By this means a fine constant feed is obtained.

ARC LAMP.



THE WATERHOUSE IMPROVED DYNAMO.

A Heavy Steel Ingot.

Vickers, Sons & Co. (Limited), River Don Works, Brightside, recently put under their forging-press the largest steel ingot ever cast in Sheffield, or probably in England. It weighed 70 tons, was 62 inches in diameter, and is for an A tube for a 13½-inch 66-ton gun at Woolwich. An A tube is the center tube of the gun, round which all the others are shrunk. When finished it will be forty feet long. This great mass of steel had been heating in the furnace for sixty hours. A porter-bar and balance weight—the latter no less than 20 tons—were used in manipulating the glowing metal, which, by means of the 150-ton crane, was quietly and quickly moved to the press, and placed on the anvil-block. Then the ram slowly and silently descended, squeezing the mighty ingot into shape under a pressure of 2,800 tons. This fine piece of machinery can be worked up to 3,000 tons pressure. The whole operation was accomplished with ease and expedition, and with an utter absence of commotion and flurry. Only the ordinary staff were employed, their magnificent mechanical appliances enabling the company to dispense with the small army of work people formerly required in such exceptional undertakings.—*The* (London) *Ironmonger.*

Beware of lawyers who, after a terrible railway accident, advertise and tender their services to persons having claims for damages; offering to proceed against the railroad company at once, and obtain a speedy payment of the claims. In our opinion reputable lawyers do not advertise themselves in this manner; it is only unprincipled men who will take advantage of disasters for their own benefit.

The lawmakers having decided that the proper way for women and children to escape from the upper stories of burning hotels is by sliding down a rope, there has been a boom in hemp and manila.

The Valleyfield Paper Mills.

These works were established in 1708, and since 1770 have been the property of Messrs. Cowan. Many different descriptions of paper are here made, including ledger papers, similar to the American description, animal-sized writing, book, and drawing papers, printing paper of ordinary character for bookwork, super-calendered for illustrations, and tough cartridge and ammunition papers. The treatment of esparto grass is carried out by the boiling processes of Roeckner and Sinclair with a caustic solution; this, while still hot, is floated into an evaporator, and incinerated to recover the soda, which is obtained chiefly in the form of the carbonate mixed with silicate and other salts. The offensive gases evolved during the process of incineration are carried into a smoke-consuming chamber, on Porion and L'Espermont's plan, where they are allowed to expand and burn, and their unpleasant smell is thereby got rid of. In Porion's evaporating plant the caustic solution is beaten into froth by revolving fans working in a tunnel of hot air. The froth bubbles expose a large surface and evaporate quickly, making the liquor thicker and more ready for the the furnace. Amongst the machines of special note to be seen at these works is a very large Forbes rag engine for beating the stuff, capable of making 16 tons of paper a week; five paper-making machines, one 78 inch, two 71 inch, and two 68 inch respectively; three long air dryers, composed of about 80 drums each; an automatic paper-winding machine, the axle of which revolves upon an inclined way; cutting machines; glazing and calendering rolls, etc. A 71 inch paper making machine makes the paper entirely from esparto.

Here also there are very complete arrangements to avoid pollution of the river. The floor washings and machine waters are conducted separately down tortuous channels, in which suspended matter is deposited. The water is then led by a single channel to a filter bed, and thence finally to the river. The channels are cleared periodically. The pulp deposited in the machine water channel is flushed into a tank through sluices at the bottom of every two lengths of the channel, and is dried and sold to packing paper makers. The boiler waters are purified in a similar manner, assisted by chemical precipitation. The deposit on the filter beds is cut out and removed. Gelatine size is also made at the works. The motive power is supplied by several steam engines, amounting to about 1,200 horse-power in all.—*Engineering.*

Modern Locomotive Construction.

By J. G. A. Meyer.

FORTY-SEVENTH PAPER.

PROPORTIONS OF CROSSHEAD PINS.

In establishing rules for determining the dimensions of a locomotive crosshead pin it will be best to base these rules on the dimensions of pins used in locomotives in actual and successful service. A great difference in the sizes of these pins exists; but in the writer's opinion the sizes given in Table 14 are a good average, and will be used in establishing the following rules. The greater number of the smaller pins whose dimensions are here given are made of cast-iron, and the greater number of the large pins are made of wrought-iron.

TABLE 14

AVERAGE DIMENSIONS OF CROSSHEAD PINS AS AT PRESENT USED IN LOCOMOTIVES.

Diameter of Cylinder.	Stroke.	Diameter of Crosshead Pins.	Length of Crosshead Pins.
12″	20″	2″	2″
13″	22″	$2\frac{1}{2}$″	3″
14″	22″	$2\frac{3}{4}$″	3″
15″	22″	$2\frac{3}{4}$″	3″
15″	24″	3″	3″
16″	22″	3″	3″
16″	24″	$3\frac{1}{8}$″	$3\frac{1}{8}$″
17″	22″	$3\frac{1}{8}$″	$3\frac{1}{8}$″
17″	24″	$3\frac{1}{8}$″	$3\frac{1}{8}$″
18″	22″	$3\frac{1}{8}$″	$3\frac{1}{8}$″
18″	24″	$3\frac{1}{4}$″	$3\frac{1}{4}$″
19″	22″	$3\frac{1}{4}$″	$3\frac{1}{4}$″
19″	24″	$3\frac{1}{4}$″	$3\frac{1}{4}$″
20″	24″	$3\frac{3}{8}$″	$3\frac{3}{8}$″
21″	24″	$3\frac{3}{4}$″	$3\frac{3}{4}$″

Crosshead pins are subjected to a shearing stress, and therefore it would seem that by making the diameter of a pin sufficiently large to give it the necessary strength to resist shearing, and then assigning to it some given length, would be all that is required. But in examining the dimensions given in the table we find the diameters of these pins to be larger than is necessary for their adequate strength. Another notable feature is that the length of the pins is, in all cases excepting three, equal to the diameter. Here, then, we conclude, and rightly, too, that there must be other considerations, besides that of strength, which the designers must have kept in view in determining the dimensions of these pins.

Let us first turn our attention to the length of these pins. We find that their lengths, compared with their diameters, are shorter than the lengths of pins ordinarily used in stationary or marine engines. The reason for making the length of a locomotive crosshead pin comparatively so short is that considerable lateral play is allowed between the hubs of the driving wheels and their boxes; and consequently, when the locomotive is running over a curve, the mechanism between cylinders and wheels will become out of alignment, which will create an extra stress on the crosshead pin. Now, in order to reduce this extra stress as much as possible, the pin should be made as short as good practice will allow, and thus reduce the leverage of the pin. Another reason for making these pins so short is that, in many locomotives, the space for the crosshead, and consequently its pin, is limited.

From these considerations, and also from the dimensions given in the table, we will establish a rule for determining the length of a locomotive crosshead pin, and obtaining dimensions which agree with good practice; hence

Rule 25. The length of a locomotive crosshead pin should be equal to its diameter.

By the expression "length of crosshead pin" is meant the length marked L in Fig. 262; that is, the length of that part of the pin which is covered by the connecting rod brass; and by "diameter of pin" is meant the diameter marked D; that is, the diameter of the same part of the pin.

Our next step will be to establish a rule for finding the diameter of the pin. Here a consideration of the greatest importance presents itself, namely, we must not only make the pin large enough to give it the required strength to do the work, but it must also have a large area of working surface, so as to avoid heating. Right here it may be remarked that when locomotive crosshead pins are correctly proportioned so that they will not heat, they will also have the adequate strength to the work, and for this reason we will leave the consideration of strength out of the question. But it must be distinctly understood that these remarks apply only to locomotive crosshead pins, or pins which are as short in comparison with their diameters.

The pressure on the piston is transmitted to the crosshead pin, and experience has shown that when the pressure on the crosshead pin exceeds a certain amount the oil will be forced out of the bearings, and consequently heating or abrasion will follow, and the only means at hand to avoid such results is to make the working surfaces of these pins sufficiently large so as to reduce the pressure per square inch. The area of the working surface is estimated by the area of a surface obtained by cutting the pin

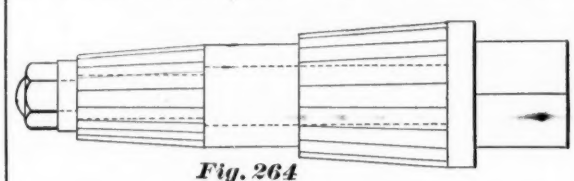


Fig. 264

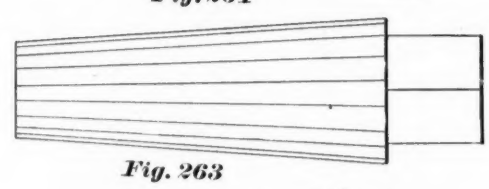


Fig. 263

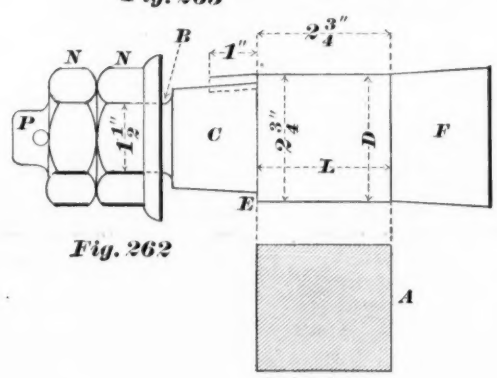


Fig. 262

Projected Area.

lengthwise through its center, as shown at A, Fig. 262. The area of this surface, that is, the longitudinal section, which is also sometimes called the projected area, is always equal to that of a rectangle whose length and breadth is equal to the length and diameter of the pin.

Since the pressure per square inch on the pin is estimated by the pressure per square inch on this rectangular surface, that is, the projected area of the pin, we must proportion this area in a manner which will not allow the pressure per square inch to exceed a given limit. Here, then, the question arises, what is this limit? To answer this question let us find the projected area of each pin given in Table 14, which is obtained by multiplying the length by the diameter of each pin; the product will be the area required. Let us assume that the greatest pressure per square inch on the piston is 120 pounds, then the total pressure on the piston, or the projected area, will be equal to the product obtained in multiplying the area of the piston by 120.

Now, dividing this product by the projected area of the pin we will obtain a quotient which will be the pressure per square inch. By so doing we find that the pressure per square inch of the projected area varies from about 2,200 to 3,200 pounds; and since these pins in Table 14 have given satisfaction, and since the dimensions of the pins in this table are suitable for cast-iron pins, and also often used for wrought-iron pins, we may adopt either 2,200 or 3,200 or any other figure between these two as a limit or standard of pressure per square of projected area. Let us adopt 2 880 pounds per square inch as a standard. We are now n a position to establish a rule for finding the dimensions of any locomotive crosshead pin, which is this:

Rule 26. Divide the total pressure on the piston in pounds by 2,880 and extract the square root of the quotient; the answer will be the diameter of the pin in inches. Or putting this rule in the form of a formula we have

$$\sqrt{\frac{\text{Area of the piston in inches} \times \text{Pressure per inch of piston}}{2880}} = \left\{\begin{array}{l}\text{Diam. of crosshead}\\ \text{pin in inches.}\end{array}\right.$$

Ex. 54. Find the diameter of a locomotive crosshead pin suitable for a cylinder 18 inches in diameter, and a steam pressure of 120 pounds per square inch of piston.

Area of 18-inch piston = 254.47;

hence,

$$\frac{254.47 \times 120}{2880} = 10.60$$

and the square root of 10.60 is $3\frac{1}{4}$ (nearly); therefore the diameter of the pin will be $3\frac{1}{4}$ inches, and according to Rule 25 the length will also be $3\frac{1}{4}$ inches.

In a similar manner we can obtain the dimensions of a crank-pin for all locomotives when the diameter of cylinder and steam pressure is given. But if we assume that in all locomotives the maximum steam pressure per square inch of piston is 120 pounds (and such an assumption is generally correct) then the foregoing rule can be made simpler, and thus obtain the following:

Rule 27. Divide the area in square inches of the piston by 24, and extract the square root of the quotient; the answer will be the diameter of the crosshead pin.

Or putting this rule in the shape of a formula we have

$$\sqrt{\frac{\text{Area of piston in inches}}{24}} = \left\{\begin{array}{l}\text{Diam. of crosshead}\\ \text{pin in inches.}\end{array}\right.$$

By this last rule the dimensions of the crosshead pins in Table 15 have been obtained. As will be seen, the dimensions of pins in Table 15 agree very closely with those in Table 14, and may, therefore, be adopted as the standard sizes of cast iron pins for locomotives in which the steam pressure in the cylinders does not exceed 120 pounds per square inch. A number of locomotive builders make the diameters of wrought-iron pins somewhat less than that of cast-iron ones, but leave the length of the former the same as that of the latter. But on the other hand quite a number of builders make the diameters of cast-iron and wrought-iron pins alike, and thereby obtain a greater uniformity in the patterns for the connecting rod brasses.

TABLE 15.

DIMENSIONS OF CROSSHEAD PINS SUITABLE FOR LOCOMOTIVES IN WHICH THE STEAM PRESSURE PER SQUARE INCH DOES NOT EXCEED 120 POUNDS.

Diameter of Cylinders.	Diameter of Crosshead Pins.	Length of Crosshead Pins.
9″	$1\frac{5}{8}$″	$1\frac{5}{8}$″
10″	$1\frac{7}{8}$″	$1\frac{7}{8}$″
11″	2″	2″
12″	$2\frac{1}{8}$″	$2\frac{1}{8}$″
13″	$2\frac{3}{8}$″	$2\frac{3}{8}$″
14″	$2\frac{1}{4}$″	$2\frac{1}{4}$″
15″	$2\frac{5}{8}$″	$2\frac{5}{8}$″
16″	$2\frac{7}{8}$″	$2\frac{7}{8}$″
17″	3″	3″
18″	$3\frac{1}{4}$″	$3\frac{1}{4}$″
19″	$3\frac{1}{4}$″	$3\frac{1}{4}$″
20″	$3\frac{3}{8}$″	$3\frac{3}{8}$″
21″	$3\frac{1}{4}$″	$3\frac{1}{4}$″
22″	$3\frac{1}{8}$″	$3\frac{1}{8}$″

REMARKS RELATING TO THE FORM OF CROSSHEAD PINS.

Cast-iron pins are cast to the crosshead; wrought-iron or steel pins are put in separate, and fit into tapered holes in the crosshead. The taper of these holes should not be too great, as an excessive taper will throw too much stress on the nuts and is liable to tear the pin at B. A good taper, and which is often used, is $1\frac{1}{4}$ inches in 12 inches; that is, the diameter at one end of the 12 inches will be $1\frac{1}{4}$ inches less than at the other end. Many master mechanics use one tapered reamer only, as shown in Fig. 263, for reaming both holes which fit the pin at C and F. Some master mechanics object to this plan, because in their opinion it does not leave a shoulder sufficiently large at E, and therefore the diameter of the pin at C is reduced, although the taper is left the same as before. For pins of this kind a step reamer similar to that shown in Fig. 264 will have to be used.

The crosshead pin is held in position by two nuts N N, and to obtain further security a split pin P is inserted in the end of crosshead pin.

All crosshead pins should be prevented from turning by a dowel pin or a small feather F, as shown.

Crosshead pins made of wrought-iron should be case-hardened.

Increasing the Tractive Power of Locomotives.

In a paper read before the American Association for the Advancement of Science, Elias E. Reis claimed the practicability of using the electric current for increasing and varying the tractive power of locomotives. Experimentally he had found it possible to increase the friction of rotating bodies 50 to 100 per cent. The increase in frictional adhesion was due, he said, to a molecular change in the conducting substances at their point of contact. We quote further from the paper as follows:

I have here a model car and track arranged to show the equipment and operation of the system as applied to railway motors. The current in the present instance is one of alternating polarity, which is converted by this transformer into one having the required volume. The electromotive force of this secondary current is somewhat higher than is necessary. In practice it would be about half a volt. You will notice upon a closer inspection that one of the forward driving wheels is insulated from its axle, and the transformed current, after passing to a regulating switch under the control of the engineer or driver, goes to this insulated wheel, from which it enters the track rail, then through the rear pair of driving wheels and axle to the opposite rail, and then flows up through the forward uninsulated wheel, from the axle of which it returns by way of a contact brush to the opposite terminal of the secondary coil of the transformer. Thus the current is made to flow seriatim through all four of the driving wheels, completing its circuit through that portion of the rails lying between the two axles, and generating a sufficient amount of heat at each point of contact to produce the molecular change before referred to. By means of the regulating switch the engineer can control the amount of current flowing at any time, and can even increase its strength to such an extent, in wet or slippery weather, as to evaporate any moisture that may adhere to the surface of the rails at the point of contact with the wheels while the locomotive or motor car is under full speed. It will be apparent that inasmuch as the "traction circuit" moves along with the locomotive, and is complete through its driving wheel base, the track rails in front and rear of the same are at all times entirely free from current and no danger whatever can occur by coming in contact with the rails between successive motors. Moreover, the potential used in the present arrangement, while sufficient to overcome the extremely low resistance of the moving circuit, is too small to cause an appreciable loss of current from that portion of the rails in circuit, even under the most unfavorable conditions of the weather. In practice the primary current necessary is preferably generated by a small high speed alternating dynamo on the locomotive, the current being converted by means of an inductional transformer. To avoid the necessity for electrically bridging the rail joints, a modified arrangement may be employed, in which the electrical connection is made directly with a fixed collar on the forward and rear driving axles, the current dividing itself in parallels between

the two rails in such a manner that, if a defective joint exists in the rail at one side, the circuit is still complete through the rail on the other; and as the rails usually break joints on opposite sides this arrangement is found very effective. The insulation of the driving wheels is very easily effected in either case.

As the amount of additional tractive adhesion produced depends upon the quantity of current flowing, rather than upon its pressure, the reason for transforming the current as described will be apparent, and its advantages over a direct current of higher tension and less quantity, both from an economical and practical standpoint, will for this reason be clear. The amount of heat produced at the point of contact between the wheels and rails is never large enough to injure or otherwise affect them, although it may be quite possible to increase the current sufficiently to produce a very considerable heating effect. The amount of current sent through the traction circuit will of course vary with the requirements, and as the extent to which the resistance to slipping may be increased is very great, this method is likely to prove of considerable value. While in some cases the use of such a method of increasing the tractive power of locomotives would be confined to ascending gradients and the movement of exceptionally heavy loads, in others it would prove useful as a constant factor in the work of transportation. In cases like that of the New York elevated railway system, where the traffic during certain hours is much beyond the capacity of the trains, and the structure unable to support the weight of heavier engines, a system like that just described would prove of very great benefit, as it would easily enable the present engines to draw two or three additional cars with far less slipping and lost motion than is the case with mechanical friction alone, at a cost for tractive current that is insignificant compared to the advantages gained. Other cases may be cited in which this method of increasing friction will probably be found useful, aside from its application to railway purposes, but these will naturally suggest themselves and need not be further dwelt upon.

Making Irregular Cylindrical Forms.

BY W. D. FORBES.

To the minds of most machinists or manufacturers anything which is truly cylindrical is associated with being produced on a lathe. Take, for instance, small V pulleys, such as are used on many small amateur and jeweler's lathes, sewing machines, etc.; in all probability there are not three places in the world where they are not turned up on a lathe, yet, for true economy, this useful tool should not be employed for the work. It is not supposed, however, that any cheaper way to produce one such pulley can be suggested than by simply forming it up on an arbor between the centers of a lathe. Making a single pulley and manufacturing a great number of them are two vastly different jobs, and in asserting that a better tool than the lathe can be found for the work, the statement only holds good for large numbers. There are in most sewing machine shops special tools on which a wheel can be bored and turned, but in these a single pointed tool does the work, or rather, several single points do so, but such tools are generally for rounding up the rim of the wheels and boring and facing the hubs.

In cases where there is a special tool, it is very well to core the hole, as the wheel cannot be taken off before the rim is turned, but the combination of boring and turning as a rule, requires a complicated piece of mechanism in comparison with a tool for each purpose, and perfect concentricity is not apt to be obtained unless an arbor is used on which to form the wheel.

The milling machine is a most economical tool on which to produce irregular forms, and at least half as much more work on small wheels can be obtained from it with unskilled labor as can possibly be hoped for with skilled help and a lathe. The first operation of boring and facing the hub is performed in the usual way, only it is recommended to have no core set for the hole, as a drill will do much faster work than a boring tool. The bored wheel is then put on the arbor of a milling machine—not a little, light trembling tool, but one able to stand up to work.

On the bed of this must be made fast a tool whose cross-section is of the desired form and the length of which is not less than one-quarter the circumference of the wheel to be turned.

To liken this tool to anything in common use would be difficult, but perhaps the nearest approach to it is the blade of a hack saw. Fig. 1 gives an idea of the tool, which is, in fact, a milling cutter having no rotary motion, but simply a feed under the work, while the work itself revolves and runs over the tool.

Of course if the cross-section was complete from tooth 1 to 7, it would be out of the question to have any result except a break up, but as tooth 1 is only a partly completed form, it cuts but a small part of the metal as the wheel revolves over it, and the second tooth has but a small amount more, and so on until the last tooth gives a complete cross-section. If the tools are properly made, after the style of the well-known Brown & Sharpe cutters, they may be sharpened without changing form, but it will surprise those who, for the first time, try this idea, to find how long the cutter will work without grinding.

This system, if one may so call it, is open to many labor-saving modifications in the machine shop. Take, for instance, the forming of hand wheel handles; although they can generally be best bought all finished, many prefer making them in their own shops, and to use the system before described, it is necessary to have a lathe on which an adjustment up and down of the tool carriage can be obtained. Take a piece of steel and work out a form to meet the desired shape of a handle, say like Fig. 2, making proper provision to secure it to the lathe carriage.

When the form is marked out to suit you it should be about six inches long over all, but the form need not run its entire length, but must be at least a little longer than the length of the handle to be formed. Now cut the end off at an angle, like Fig. 3 (which is looking down upon the tool), the angle depending somewhat upon the nature

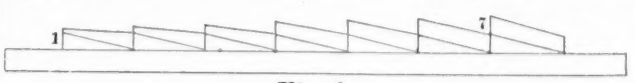


Fig. 1

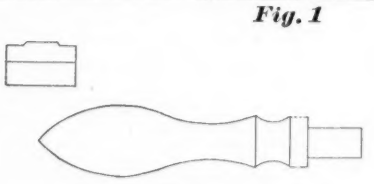


Fig. 2

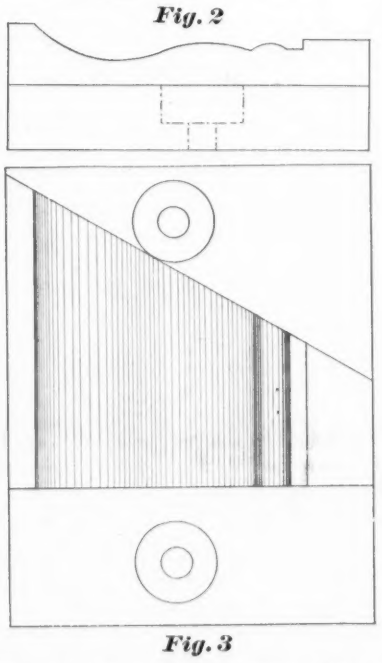


Fig. 3

MAKING IRREGULAR CYLINDRICAL FORMS.

of the work, whether it will stand a good chip without springing. After hardening, place the former tool on the lathe carriage firmly, and adjust it to a height which would just nicely skin the roughed out form.

Now start your lathe *backwards*, put on a fair speed and throw in your cross-feed, giving it rather a slow motion, and when the tool has passed under the work, as perfect a form as you could desire will be the result. Such a former tool must be kept nice and sharp, or the work will show it and poor results will be obtained.

Such former tools can be used to very great advantage on brass goods; in fact, air cocks are constantly made with their aid, as are many other brass articles.

It is said that the Standard Oil Company have plans for a fleet of steamers for carrying oil in bulk, each steamer to be capable of carrying 700,000 gallons.

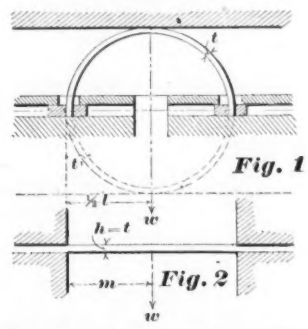


Fig. 1

Fig. 2

THE SPRING ROLLER PROBLEM.

LETTERS FROM PRACTICAL MEN.

Shrinkage of Cast-Iron.

Editor American Machinist:

In your issue of Aug. 27, Mr. Masters, in referring to what I said about shrinkage of cast-iron, made some good remarks. One especially struck me, where he said, "A little intelligent discussion will bring better results." What I tried to show at the time referred to was that the shrink rule now generally used—viz.: the $\frac{1}{8}$ inch to the foot shrinkage—was too much, and that for general work a rule with $\frac{1}{16}$ inch to the foot shrinkage would be more suitable. I suppose a shrink rule that would do for all kinds of work would be a remarkable one. Different shrinkage often occurs on two similar castings, notwithstanding they may be of the same grade of iron. Should one be poured with hotter metal than the other, which is often the case, there will be a difference in the shrinking, so that this would also have to be attended to as well as the grading of the iron, as of course Mr. Masters very well knows; but it is the shrinkage of the average run of castings we want to get at.

I am very fond of measuring castings to see what they have shrunk, and so far I have found that dry sand castings do not shrink as much as green sand castings; this is contrary to the table of shrinkages given by Mr. Masters. My individual experience in this may not amount to much, but it can be taken for what it is worth.

Not long ago we made some large legs for some Boyle ice machines. The first were made in green sand and came out right for length, with just the right finish on each end; the second lot we made in dry sand, and they all came out too long, and if we finished them to the proper length the flanges would have been too thin. I do not think a probable difference in the grade of iron did it either, because they were cast at different times, and invariably the dry sand castings were the longest.

Chicago, Ill. P. S. DINGEY.

The Spring Roller Problem.

Editor American Machinist:

I have become much interested in the "spring roller problem" as put forth by John E. Sweet, and I would offer to him the following as the "mathematical" solution, for it seems to be the only way the problem can be satisfactorily solved. I will not go into the detail of deriving the formula for deflection, for it would be uninteresting to those who would not understand it and it would be like repeating an old story to those who do understand it.

Referring to Fig. 1 we will suppose the roller to be bisected by a horizontal plane, and the two ends fastened rigidly to blocks, which are free to move in a horizontal direction only. It will be seen that these conditions are exactly the same as when the half was a part of the roller, as far as the action of the force upon the roller is concerned. The angle of the ends being kept 90° with a horizontal line.

The problem now resolves itself into calculating the deflection of a curved beam loaded in the center and fixed at the ends. As the lower half will deflect the same amount as the upper its deflection will be $\frac{1}{2}$ of $\frac{1}{16}'' = \frac{1}{32}''$.

Since the greatest bending moment of a beam is the weight it carries into the perpendicular distance between the support and the line of action of this weight (m, Fig. 2), the greatest bending moment is the same for any beam between the same supports, other conditions being the same. As it is this moment that produces the greatest deflection and requires the greatest strength of the beam, the size and deflection of the straight and the curved beam will be the same.

We have now only to use our formula for deflection of straight beams to find the thickness of roller with the $\frac{1}{16}''$ deflection.

The general formula for deflection of a straight beam loaded in the middle and fixed at the ends is:

$$V = \frac{W l^3}{192 E I}$$

W = the weight = 750 lbs.

l = length of beam = diameter of spring roller = 3.5″.

E = modulus of elasticity = amount a piece of the metal 1″ cube will stretch under a load of 1 lb. = 30,000,000.

I = moment of inertia = $\frac{b h^3}{12}$ $b = 1\frac{7}{8}$ $h =$ h thickness of roller = t.

V = deflection of beam = $\frac{1}{32}''$.

Putting in the formula for the letters their respective values:

$$\frac{1}{32} = \frac{750 \times 3.5^3 \times 12}{192 \times 30{,}000{,}000 \times 1.875 \times t^3}$$

$$t = 3.5 \sqrt{\frac{750 \times 12 \times 32}{192 \times 1.875 \times 30{,}000{,}000}} = .10457''$$

F. A. NOBLE.

Making Tight Joints Without Scraping or Grinding—Grinding Twist Drills.

Editor American Machinist:

I wonder if any good ever comes from taking an inventory of one's own shortcomings? In skirmishing around in this direction this thought presents itself: Which of three things is the easiest to do—to forget, to make mistakes, or to find fault with other people. This latter weakness, together with a disposition to tell all the things that I know, and a great many that I do not know, are among the minor faults that I plead guilty to, and I seldom think of them without calling to mind Josh Billings' proverb, "that one better not know quite so much, than to know so much that ain't so."

I think a careful review will show that in the practice of medicine, among the things about which the medical profession were the most certain they were right, they now admit they were wrong. I believe many things about which the most scientific mechanics and scientists were the most sure of all things that they were right about have been shown to be wrong; and I am equally sure that among many of the things in practical mechanics about which we have all along and still feel most sure we are right in following, we are just as far out of our reckoning as the theorists. It's easy to forget, it's easy to find fault with other people, and it's a very easy thing to be mistaken.

The above sounds like the beginning of a sermon, but is nothing more than a text, and will likely bear the same relation to what follows, and it is hoped it will have the same effect that the Sunday morning church bells do on the religious services.

As an example of the things thought to be the best, and which I think it can be easily shown are not the best in practice, is the method of making a steam-tight joint

between the cylinder and cylinder head of an engine. It is safe to assume from the catalogues and practice of steam engine builders that what is supposed to be the best way to make the above joint is by scraping or filing and then grinding the two together. We find that a common job of lathe work on both, put together dry, and bolted up, makes a tight job, and one that can be taken apart and put together any number of times and still be tight, if in every case it is brought up evenly. The trouble is, every engineer wants to put on something, and when instructed to let it alone and put it on just as it comes off (except to wipe it clean), every young Lord Bacon that comes along has to tell him of some new stuff to put on, and whatever it may be, except nothing, does more harm than good. There is hardly anything that anyone is likely to suggest that will not make a tight joint the first time, but the trouble comes from having to scrape it off before replacing the head the second time. The chatter marks from a scraper leave radial streaks, out of which the steam finds its way, and when once started the plan is defeated.

I shall not be surprised if your readers are informed that there is nothing new about this, and of engine builders who have practiced it with success for twenty years; for, in fact, I was myself told that this was the correct way to put on cylinder heads twenty years ago, but did not believe it, and shall be more surprised if any one believes me than if no one does.

When one takes more than ordinary pains to know he is right, it is a consolation to be believed, but, unfortunately, one cannot always be right, and people are as likely—more likely, I think, sometimes—to believe the things that are wrong than those that are right, and hence Josh Billings' remark: "We had better not know quite so much than to know so much that ain't so."

One thing I have been wrestling with for several years and make no headway—and that is a better way to grind twist drills. I feel very sure I am right about it. If right, I make few converts, and if wrong I have made no victims, or, at least, none that make the fact known.

Fig. 1 shows a twist drill ground in the ordinary way, and Fig. 2 the way one looks when ground according to my notion, for which I claim these advantages: 1st. That it will drill faster, and when broken that only a small piece of the end will be broken off, and hence the loss from broken drills will be less. The objections raised by those who judge from appearances, I fancy, are that the drill is much weaker, and that when it gets nearly through a piece it will drive through at a jump. That these objections are fanciful, I believe—first, because I have failed to find it so, after years of use; and second, I think it can be shown by careful reasoning that the first is only true to a beneficial extent, and the second is not necessarily true to any extent.

Fig. 3 represents to scale the developed surface* of a twist drill of uniform pitch—and if allowed to represent a planer tool for working in a straight line, will serve to illustrate the point I wish to make. Assume the tool to project below the tool holder, as shown at point *a*. This tool in the act of cutting would be strained the same as a beam supported at one end and loaded at the other, and it is claimed to be just as strong against a steady pull if cut off to the dotted line as if left full size (not as stiff, but as strong). If that is true then if cut as shown in Fig. 4 it would still be as strong, about as stiff, and sure to break, when it did break, at *b*.

The method of grinding shown in Fig. 2 aims to approach the condition above described, that is, to grind the drill so that when it does break it will break only a little above the point and in such a direction that the drill is free and may be stopped without further harm.

The man who never breaks a twist drill never finds out how much they will do, and the man that does break them knows very well that usually if ground in the ordinary way they break in the manner indicated by the dotted lines in Fig. 5. If ground the other way they break as shown by dotted line in Fig. 6, and that is the end of it. That the drill is a little weaker at the point where it breaks than if ground in the ordinary way, I admit, but only slightly weaker, as may be seen by observing Fig. 7, and I claim that this weakness is more than balanced by the advantages

The reason a drill will drill faster if ground as shown in Fig. 2 than as ground by the makers is this: When the curved surfaces of the two lips come together they form a rounded point approaching a cone, and if the point was a true cone the drill would not cut at all, whereas a drill ground as shown in Fig. 2 has a square point which will nose its way into the metal better than the one more conical.

Fig. 1

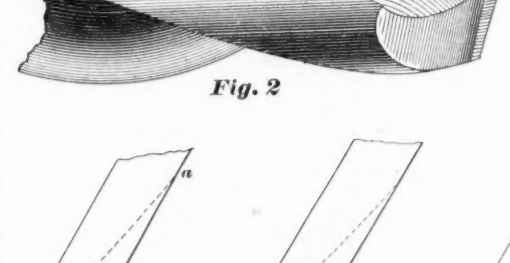


Fig. 2

Fig. 3 Fig. 4 Fig. 5 Fig. 6

Fig. 7 Fig. 8 Fig. 9

GRINDING TWIST DRILLS.

In regard to a drill driving through the hole when the hole is nearly finished: Let *a*, Fig. 8, represent a horizontal line, *b* an inclined line showing the direction of the cut as made by the drill in its work, and *c* the clearance given to the under side of the drill. It will be seen that it is only possible for the drill to go through the hole as fast as the angle of clearance will allow.

From Fig. 9 it will be seen that the clearance of the cutting lip is the same as in Fig. 8, and also that what may be called the heel *d* of the clearance coming nearer to the cutting angle will prevent the drill from going through as abruptly as the one shown in Fig. 8.

Grinding twist drills in the usual way, to the man who learned his trade on the flat drill, to the apprentice and to the average machinist, is a job that "rattles" them. To the man who learned on the flat drill plan No. 2 is the easiest. The apprentice can learn one way as well as the other, or would if the makers set the example, but as to the average journeyman machinist—well, I guess he will have to have a machine to do it to his own satisfaction, whichever way it is done.

JOHN E. SWEET.

*To those of your young readers—and I hope there are many—who may not understand what is meant by a developed surface, I beg to suggest the following, which will not only give the best possible conception of what is meant, but will also enable them to perfectly understand the balance of this article, and besides, teach a dodge worth knowing: Take a new twist drill and wrap partially around it a piece of paper, and indent it over the corners and lower end of the drill; then spread it out flat and mark on what was the outside, with a pencil, marks where the dents were made, and it will be seen that the drawing thus made will look like Fig. 3. Then grind a drill, as shown in Fig 2, and follow the same plan, and it will be found to look like Fig. 6.

Locomotive Conveniences.

Editor American Machinist:

I notice Mr. Hill's letters of recent date refer to some of the small conveniences about the locomotive, that, when coupled together, go to make up the comforts or discomforts of the locomotive engineer's life. The men who live a large portion of their time on the cab desire and deserve to have things convenient and handy, and our master mechanics should try and arrange things about the engine so that the engineer and fireman will not have to worry about small things, such as a torch, oil can, or monkey wrench. I like Mr. Hill's suggestion about the oil can spout being screwed in to top of can, and let me add that a wire netting tube about 3″ long should be soldered to the large end of the spout, so that it will stick down in the can and prevent any dirt getting into the spout.

I also have thought during the late hot season that a skylight roof on the cab, such as we have on a passenger coach, would be a great help in the summer time, to let out the hot air that accumulates about the engineer's head, which should be kept cool. The whistle and safety valve levers could be passed through the raised end of the cab instead of coming down through the top, and windows with screens arranged so as to make the ventilation perfect.

Another convenient thing is a squirt; just tap a hole in the injector feed pipe, screw in a cock and attach a pipe leading into the cab; attach a small hose and you can throw water over a three-story building. It comes handy to wash the deck, wet down the coal, dampen the ashes in the ash pan before scraping them out, etc., etc.

In fact, there is no end to the improvements that might be made on some locomotives, and such articles as Mr. Hill writes are calculated to set men to thinking, and thus lead to good work. W. M. M.

The Shaper vs. the Milling Machine.

Editor American Machinist:

There seems to be a growing impression among mechanics that the planer and shaper cannot compete with the milling machine either in quantity or quality of work produced. Perhaps the planer is an obsolete tool, but I am skeptical about it. Years ago I supposed that any class of work like gear or rack cutting could be much more rapidly done with a milling machine than with a planer, but experience proved that in my case at least I was mistaken. A certain class of work required steel rolls 4″ long and 4″ diameter spirally grooved. We had no milling machine, so one was made from the 18″ New Haven lathe; a rigid cutter arbor and everything stiff. It looked as if the work could be rapidly pushed along. The slide that held the roll was fed to the cutter by the cross-feed screw, and run back by hand. The machine worked beautifully, but it took too much time. A rack and pinion-feed was substituted for the screw-feed, and a heavy weight attached to the back of the slide, so that at the end of the cut the rack could be lifted from the pinion and the work would drop back. It was a quick return of the quickest order, but still the work progressed too slowly. The cutters were good and doing good work, only not enough of it. About that time I read a description of Mr. Bilgram's gear cutter. Immediately a pair of centers were put on the shaper, a rotating and spiraling device added, and a roll grooved on the shaper. Strange as it may appear to the milling machine men, the time required for grooving a roll was reduced 60 per cent.

Since that time I have had several little experiences in rack cutting, and have found the planer the more economical tool to use.

F. L. JOHNSON.

Holland, Mich.

A Boiler Explosion Expected.

Editor American Machinist:

In a location to which I recently extended my observations they are boring a 5 inch well. The men in charge of the portable engine were afraid to carry a higher pressure than 60 pounds. The other day while the employes were grouped about the well, the engine took care of itself for a while. When the pointer reached 118 the rubber gasket between the steam pipe flange and the steam dome blew out. Those who were not already standing rose at once to their feet. The safety valve, however, not conscious of any neglect of duty, remained seated. One of the two $\frac{5}{8}$ inch cap screws which held the flange to the dome was found to be broken in two. A new screw and gasket were put in, and when the machinist turned his attention to the safety valve, the order was given something like this: "Never mind the safety valve, we're not afraid of the old thing now."

When I hear of a boiler explosion in that vicinity I will let you know of it.

J. E. MCCONNELL.

Des Moines, Ia.

Diversion of Trade from England.

Our English friends are considerably exercised over the fact that they are losing trade which they think should come to them; to such an extent has this gone that Lloyds has issued a pamphlet on the subject. Even the Suez Canal has proved comparatively damaging to the trade of England, in that it has helped other nations more than it has helped her. Some quotations from this pamphlet are instructive, in that they contain lessons that should be heeded in every country. As for example:

"In the present day the spirit of enterprise seems to have departed from the British race. Young men of every profession seem inclined to pursue easy lives at home rather than undertake the hardships and discomforts entailed by foreign travel and foreign enterprise. Germans seem to occupy in the world now much the same position as was held by the Scotch in England in the time of Dr. Johnson. They appear to do business more cheaply than anybody else; and although they will be, no doubt, cordially detested for doing so, they must be successful if Englishmen will not endure the discomforts which must be suffered, to compete successfully with them."

And the following:

"The commercial education of Englishmen appears to be most faulty. Whilst in almost no parish school in Germany there are not a large number of boys who can write and even speak English easily, there is probably not a single public schoolboy at Harrow, Rugby, Winchester, or Eton who could write an intelligible sentence in German. Languages which might be really valuable in the struggle of life are placed on one side, and boys are crammed with Latin and Greek, which they take very good care to forget six months after leaving school. The great want of technical and commercial education is manifest to anybody at all acquainted with the commercial world."

Commenting on some portions of the pamphlet, our English contemporary, *Iron*, from which we make the extracts, remarks:

"We have so long and so easily carried all before us in trade that probably we have become careless and thoughtless on many points. The new stress of competition and the influence of stern reminders such as this

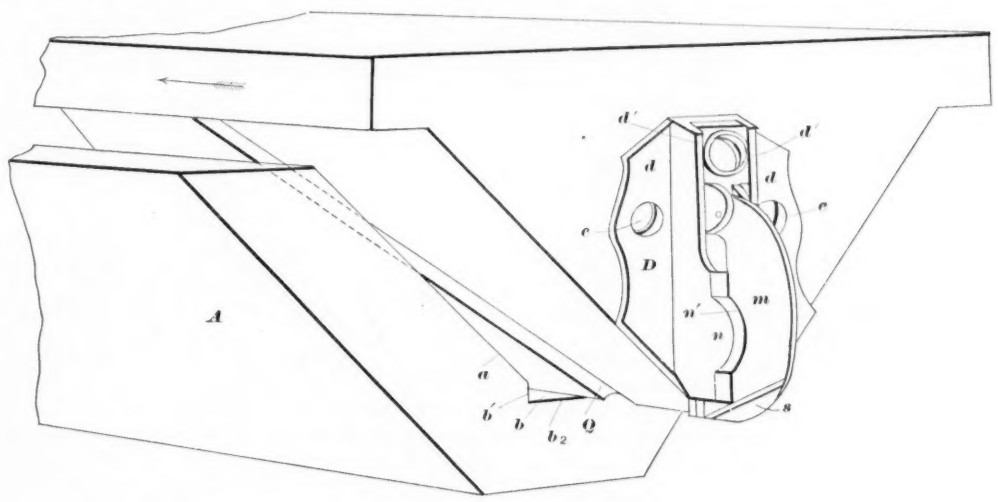
from the corporation of Lloyds will, it is to be hoped, have the effect of awakening all concerned with our shipping, our harbors, the training of our youth, and so on, to the necessity of carrying out the many reforms which the altered situation demands.

England, it appears, is learning the lesson of over-confidence, and will no doubt apply heroic remedies. But there is in the whole matter a palpable lesson not only for nations, but for individuals as well. No one can prosper long on the deeds of others. Prevention is better and cheaper than any remedy is likely to be.

Lubricating Device.

The device herewith shown is the invention of John T. Waters, Massillon, Ohio. It is more particularly designed for use on planers, the manner of attaching for this purpose being shown in the engraving, *A* representing the shear, provided with the usual V groove *a*, and a groove *b* for the lubricant. There are also, as shown, oblique grooves in the converging sides of the platen.

The frame of the distributor is shown at *D*, being made of suitable form for attaching to the platen. An abutment stem *m* is adapted to swing between guide cheeks *n*, being pivoted in such a way that it can rise and fall a limited distance, as well as swing. The piece *m* is provided at its lower rear end with laterally extending wings, which spread out to a distance about equal to the width of the groove *b*. The abutment can swing a fixed distance either way, to be in proper position for forward or backward movement of platen. When the platen is moving in the direction indicated by the arrow, the abutment is thrown into a position in which the lower end will be near the bottom of groove *b* The result will be the formation of a wave of lubricant in front of the abutment, and the forcing of it up the oblique groove and on to the sides of the platen between the bearing surfaces. When the planer moves in the opposite direction, the lower end of the abutment is mechanically elevated, passing over the lubricant.



LUBRICATING DEVICE.

We see it stated that it is now a settled fact that the $15,000 price battle ship, designed by the Barrow Shipbuilding Company, is to be built at the Brooklyn Navy Yard. The additional cost for the working drawings will be $6,900, making the design cost the Navy Department $21,900. In connection with this statement we would say that the working drawing, if made by private firms, will cost considerably more than $6,900. We believe double that amount will be nearer correct. If these drawings are made in the navy yard, particularly near election time, which is now approaching, $6,900 will be but a fraction of the cost of the working drawings.

A Hint to Hardware Merchants.

A foreign journal of recent date draws the attention of iron merchants and hardware manufacturers in Great Britain to the fact that Chinese are now building their houses somewhat after the foreign style, in the way of substantial doors and windows, and that the manufacture of locks and hinges of brass or iron for use among the Chinese may prove to be a very profitable venture. These locks should be simple in construction, durable in use, and cheap in price. Glass or porcelain knobs are preferable to brass knobs. The keys may be cast or stamped, and should be light and elegant in shape, galvanized, if made of iron, or nickeled in the better kinds, so as to preserve them from rust in damp climates. All locks need not be mortise locks. Some may be made to fit on the inside surface of a door. As to hinges, these may be made of galvanized iron or brass. In case of large hinges, iron is preferable to brass, on account of its cheapness, as well as its toughness. In all cases where large hinges are necessary, they ought to be of a shape or kind that would strengthen the framework of the door, as well as to support it. If the manufacture of this hardware should be profitable to the English manufacturers, why should it not be so to the American manufacturers?

It is said that iron may be effectively freed from rust by immersion in a nearly saturated solution of chloride of tin. The duration of the immersion will depend upon the thicker or thinner film of rust; in most cases, however, twelve to twenty-four hours will suffice. The solution of chloride of tin must not contain too great an excess of acid, otherwise it will attack the iron itself. After the articles have been removed from the bath, they should first be washed in water and then with ammonia, and dried as quickly as possible. The idea appears to be of German origin, which is all we know about it.

The Apprenticeship Question.

There is one weak point in apprenticeship as carried out in this country; that is an almost entire lack of provision for teaching the *why* of what the apprentice does. It may pretty nearly be said that there is lack of intention to do this. So boys go on to the end of their apprenticeship, requiring four times as much telling—it cannot be called instruction—as they otherwise would, and in the end there is woeful lack of what they are entitled to. If every time an apprentice in the machine shop was told to use a certain kind of tool, set in a certain manner, for a new job, he was made to understand why he should do so, he would soon need comparatively little instruction. Telling him to work in a certain way on a job may fix him all right for that job; making him understand why, may be all the instruction he will need on a dozen jobs that follow this. Foremen are apt to think they have no time to more than indicate how a certain piece of work should be come at. It is true that the great majority of foremen have very little time to devote to apprentices, but if an extra five minutes spent in reasoning will save telling practically the same thing a hundred times over, then it is economizing in time to spend the five minutes. There would be more studious mechanics and fewer routine workmen if boys were set thinking more while learning their trades.

There is in machine shops a lack of proper arrangement for an apprentice to learn what he is justly entitled to learn. This is not only injustice to the boy, but it is direct loss to the firm or proprietor. After all, we are inclined to favor, for large shops, the plan outlined some years since by a correspondent of the AMERICAN MACHINIST, and which is just now receiving a good deal of attention in England, viz.: having an instructor for apprentices. Foremen may be too busy otherwise, or may not possess the happy faculty of getting a good deal of work from apprentices and at the same time imparting a good deal of information. At any rate, it is a fact that, in this country, the apprentice has to depend mainly upon the journeymen in a shop for what instruction he gets. As the latter do not generally consider themselves under any obligations in the matter, the boy has to fight his way along without much in the way of help. This is all wrong. It is not what is understood by the terms of apprenticeship. A few boys will come out all right, but the majority get discouraged and settle down to the stultifying plan of doing as little thinking as possible. Just what they ought to have learned, that is, to think, they have not learned, and there is a fair chance that they never will learn it, because they were not started right.

Nine-tenths of all the talk we hear about the failure of the apprenticeship system comes from pure failure to carry out what is implied. As a matter of fact, there never was any apprenticeship system in this country, but there is a substitute for one that can be made to work well. The true way to learn the "mysteries" of any trade is through an apprenticeship to that trade, and in time—not a very long time—this will be understood in this country. Already in England this fact is forcing itself on the minds of some of the best thinkers upon the subject; a little later it will come here.

The idea that in the leading trades, that is, the trades where the greatest amount of diversified skill and the most thought are required, the work is to be so systematized that mechanics will not be required, is a popular delusion, and it is likely to be a costly one, unless better sense prevails.

The belief in England to-day is that the apprenticeship system should be improved; that from that shall come the mechanics who have for so many years kept up the supremacy in manufacturing. We believe they are right. We fully appreciate the great importance of our technical schools. They ought to be sustained and multiplied. But when manufacturers—especially in the machine line—make the attempt to keep up their supply of skilled workmen otherwise than by some system of apprenticeship, then we believe they make a serious mistake.

We have been at some pains to look into this matter. So far as our observations extend, in machine shop practice, we find that in the majority of the shops best known in the country there is some system of apprenticeship. In those shops a goodly proportion of the mechanics employed are those who learned their trades there. They may have indulged the machinist's propensity for traveling a little, but in the end have gravitated back to the scenes of their early friendship, and their presence always helps the reputation of the shop.

There is a proposition to abolish telegraph poles in New Orleans, iron towers being used as a substitute. These towers it is proposed to erect at the corners of streets, and of such a height as to carry the wires above the buildings.

Gelsolino is the name given to a new material resembling silk. We are indebted to a writer in the *Journal Commercial et Maritime* for this information. The writer says that two students in Italy have invented an apparatus the object of which is to substitute mulberry fiber for cotton, and give it the above name. On removing the bark from the young shoots of mulberry trees, a fiber is found, which in fineness and tenacity is not exceeded by silk; and the object of the invention is to treat the bark and isolate the fiber by a mechanical process. The English houses are said to have already made offers to purchase the entire production emanating from this novel process.—*Engineer and Iron Trades Advertiser.*

What is said to be a valuable alloy of nickel aluminum and copper is thus described: To the melted nickel the charge of copper is stirred in, and subsequently, at a somewhat higher temperature, a proportion of aluminum, varying, according to the percentage of nickel, from 1.75 of aluminum per 1,000 of the mixture in the case of an alloy of 10 per cent. of nickel, down to 0.5 of aluminum per 1,000 for one with 40 per cent. of that metal. The fused mass is then raised almost to its boiling point, and poured rapidly and regularly. Malleable nickel may, in part, be substituted for aluminum, but with less satisfactory result.

There is in railroad matters, as in everything else, such a thing as killing the goose that lays the golden egg. In conservative England there is a party of considerable strength that believes that the Government should own and control railroads. And this party is composed of business men and manufacturers, moved to the attitude they assume because they believe that railroad corporations are governed in their charges only by the limit which shippers can be made to stand.

It is undoubtedly a fact that considerable progress is being made in this country in the use of electric motors, both for tramways and for furnishing small power in factories. There has been a superabundance of smoke about the matter of making and introducing electric motors and engines, and we are glad that there has been some fire.

Master Car-Builders' Circulars.

The following from Secretary Forney explains itself:

MASTER CAR-BUILDERS' ASSOCIATION, OFFICE OF THE SECRETARY, 45 BROADWAY, N. Y.

The circulars and cards for the letter ballots, ordered by the Master Car-Builders' Association at the Minneapolis convention, have all been sent to members of the association by mail. If any member has not received the circular, he will confer a favor on the secretary by informing him at once.

The subjects of the letter ballots are:

1. "Standard Type of Coupler;" 2. "Rigging for Non-Automatic Draw Gear"; 3. "Standard Axles, Journal Box, etc., for Cars of 60,000 Pounds Capacity"; 4. "Standard Sizes of Lumber for Freight Cars."

M. N. FORNEY, Secretary.

An automatic damper regulator for steam heating boilers, in use to some extent in England, gets its regulating power from the temperature of the water circulating in the pipes. A copper rod of considerable length extends through one of the pipes, and this by its expansion and contraction opens and closes the damper through suitable multiplying mechanism.

The Lehigh Valley R. R. are about to introduce the system of telegraphing from moving trains.

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☞ *Positively we will neither publish anything in our reading columns for pay or in consideration of advertising patronage. Those who wish to recommend their wares to our readers can do so as fully as they choose in our advertising columns, but our editorial opinions are not for sale. We give no premiums to secure either subscribers or advertisers.*

☞ *Every correspondent, in order to insure attention, should give his full name and address, not for publication, but as a guarantee of good faith.*

☞ *We are not engaged in procuring patent rights, or in selling machinery, nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draftsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ *Subscribers can have the mailing address of their paper changed as often as they desire. Send both old and new addresses. Those who fail to receive their papers promptly will please notify us at once.*

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NEW YORK, SEPTEMBER 17, 1887.

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Social Recognition and Municipal Booms.

A well-known mechanic says he would prefer a certain town as a place to live in to any other that he knows of, for the special and express reason that a capable mechanic is better received socially by its wealthiest and best known citizens than is the case in some places that can be named elsewhere. There is more in this remark than appears upon the surface.

There are places in all parts of the country, and notably in the older portions, to which capitalists and "leading citizens," to use a hackneyed phrase, would be very glad to welcome new manufacturing enterprises. But very often they forget that social recognition would accomplish more, and cost less, than many other of the "inducements" that are so lavishly paraded. Like everybody else, mechanics appreciate social attentions, and perhaps the better mechanics they are, the better they like them.

And it is just possible that, in extending courtesies of this kind to mechanical newcomers, taking account of individual worth rather than of money or occupation, the capitalists and leading citizens aforesaid may find their own intellectual and moral horizon, and that of their families, broadened to an extent not previously looked for.

"Increasing Suburban Traffic."

In our issue of August 1, 1885, under the above heading, we called emphatic attention to the mistake many railroad officials were making in neglecting the profitable suburban traffic that would almost build itself up if given half a chance, while straining every nerve to shorten time on long distance passenger traffic. Without mentioning any names, we instanced the case of a railroad we knew of that well illustrated the folly of the whole proceeding. We were glad to learn not many months afterwards that the railroad in question had, since our article in question was published, inaugurated a series of important reforms, looking in the direction of more trains and better service for that kind of traffic. One thing is just as clear now as it was then, that for roads running out of large cities it is poor policy to insist that suburban neighborhoods must fill up with people before decent train service is allowed them. Without decent train service how can such neighborhoods fill up with people?

But we believe the road in question, and many others, could gain much by adopting our suggestion made at the same time, calling for the substitution of quick-starting engines of the Forney or some similar type, for the locomotives required for regular long-distance traffic.

We are glad to see that a late issue of the *National Car and Locomotive Builder* reenforces our argument upon both points in a strong editorial article, and hope that railroad mechanics generally will give attention to this subject. In the editorial above referred to the writer points out some of the requisites of a locomotive for this purpose, viz., ample cylinder capacity to force the train up to speed quickly, and plenty of weight on the drivers. The wheels, the writer concludes, need not be much more than 4½ feet in diameter, and the tender ought to be small—just large enough for the purpose—thus avoiding dragging useless dead weight. The cars should be light but strong, easily kept clean, and easily kept warm in winter and cool in summer.

In 1883 a law was passed by the Legislature of New Jersey, the provisions of which were, amongst others, that no child between the ages of 12 and 15 years shall be employed in any manufacturing establishment, unless such child shall, within the year immediately preceding such employment, have attended some school, either day or night, for a specified length of time. The inspectors appear to have endeavored to enforce this law in a manner to work the least possible hardship, but they have up to this time been hampered because the school facilities in the cities of the State are entirely inadequate; the children are denied admittance to the schools for the reason that they are always full. This is not a creditable state of affairs. The State elects, and in this is right, that the children shall have some little education at least, but in the four years since the passage of the bill has utterly failed to provide the opportunities. If the law were strictly enforced it would prevent children from working as a penalty for not accomplishing the impossible, viz., going to school when they are denied admission. Some of the industrial establishments in the State have established night schools, and in this way the provisions of the law are complied with, but it manifestly was not the intention of the lawmakers that this should be the outcome of their legislation on the subject. One more law is required, and that to the end of compelling the cities in the State to provide adequate school facilities.

Forming Boards of Trade.

One of the best things about the industrial movement that has been manifest for some time past all over the country, is the tendency toward joint action on the part of citizens in the formation of Boards of Trade in cities, towns and villages.

A purely real estate basis is a very poor basis upon which to set forth a town's advantages as a manufacturing or business point. Interests that are individual and selfish merely, are liable in many ways to oppose themselves to the general good, or to seriously confuse the issue in such cases. But the arguments and activity which are based on the joint interest of the entire community, as represented in an enterprising Board of Trade, are subject to no such danger, and under proper guidance, can be made useful to the whole community.

Several failures of air brakes recently emphasize the fact that the best safety devices must have some attention if it is expected that they will work satisfactorily. Neglect to properly handle the brakes appears to have caused all the trouble there was in all these cases. There is in human nature a common weakness in the direction of supposing that a particularly good thing in the mechanical line ought to take care of itself. The air brake mechanism that is neglected fails to work some day, no matter how nearly perfect it was originally; the boiler that is made of the best material and in the best manner, it is sometimes apparently thought ought to take care of itself indefinitely, but it fails mysteriously. The best steam engine is the one that is the most persistently neglected; the modern safety valve is so immeasurably superior to the ancient kindred device that it is presumed it should keep itself in condition through months of inactivity, and so on with a hundred things. Sometimes it is honestly argued that the rudest primitive arrangement is the best, or at least the safest, because it will not be assumed that it will do anything without help. But this argument simply resolves itself into one for a little care of the thing that is good in itself. Modern machine tools, for example, can be made to do much more work than those of thirty years ago, but no one would argue that the old ones were the best, because, if kept in bad condition, the new ones would do more poor work than the old ones.

A local celebrity, Hon. C. C. Comstock, in an interview with an emissary of that enterprising journal, the *Telegram-Herald*, of Grand Rapids, Mich., outlines a thought that ought to be seriously considered by manufacturers and workmen alike in every town and city in the country. He says:

And I will say here that the council has a great deal to do with the prosperity of a city. The aldermen can do more to help or hinder the growth of the city than all of the business men combined, and I have always noticed that when we have enterprising, progressive men in the council, improvements of all kinds flourish, while everything lags when the council is disposed to halt and haggle over every little objection that is raised to the projection of new enterprises.

As a nugget of solid truth, the words quoted above cannot be better stated. There are plenty of towns and cities all over the country which are little else than municipal graveyards. Enterprise is dwarfed and crippled, and warned off every time the city authorities meet each other or other citizens, and every time the tax assessor makes his rounds. And it is not easy to say which is more disadvantageous to a town or city—to be governed by unprogressive men in the present, or to have been governed by extravagant ones in the past.

These things being so, let every man resolve to do his part in the selection of the right men, on the right grounds, and in the right way, for such places of public usefulness.

The *English Mechanic* of August 19 reproduces (of course with the fair credit characteristic of that sterling journal) the description and engraving of the Sellers tool-grinding and shaping machine, shown in our issue bearing advance date August 13. The engraving has been reproduced by some "process" that, we are bound to say, prints better than any of the photo-engraving processes in vogue on this side of the water. The cut is so well reproduced, in fact, that even the New York wood engraver, whose autograph appears in the corner of the reproduction, has very little just cause for complaint.

Literary Notes.

AUTOMATIC FIRE SPRINKLERS. A Text-Book (Revised Edition) Compiled by the Edward Barr Company (Limited), 78 John street, New York, for the use of Manufacturers, Mill Owners, and Fire Insurance Companies. Price, 50 cents. New York, N. Y. Economical Printing Company, 24 Vesey street.

This is a pamphlet of about 60 pages of reading matter. Its title appears to us not to have been happily chosen. It is true that three or four pages are devoted to a brief mention and condemnation of other systems of sprinklers, but almost the entire work is used as an advertisement of the system controlled by the company named on the title page. When the reader has read the book, including several pages of testimonials, and a list of those using the sprinkler eulogized, we are sure he will wonder why the pamphlet is called a "Text-Book."

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly, and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(372) G. W. H., Minneapolis, Minn., asks: How can I case-harden iron so as to get the variegated colors? *A.*—You can get a fine color on small pieces by bringing them to a red heat in a clean fire; then sprinkle prussiate of potash over them and cool in water. The case-hardening, however, will not be of much depth. When there are a number of articles to harden, it is better to make a cast-iron pot or box with a cover which can be made tight by using fire-clay. Put the articles in this box together with crushed bone, burnt leather scraps and charcoal in equal quantities. Heat the whole to a red heat, and keep hot from one to five hours, according to size of articles and depth of hardening desired; then remove the cover and dump the articles into water with the least possible exposure to the air. This will harden to considerable depth.

(373) W. L. H., Wallula, Wash. Ter., writes: 1. Would like to know how the water brake works, as used on locomotives for heavy grades. What advantage has it over air brakes? *A.*—In our opinion it has no advantage over air brakes. In fact, the few locomotives that we have seen to which the water brake was attached also had an air brake; so that, in case anything should interfere with proper action of the air brake, the

water brakes could be used. In these cases the water brake was for the purpose of promoting safety, and to have greater means at hand to avoid serious accidents. 2. In the engineers' brake valve (Westinghouse air brake) there is a small hole under the main discharge outlet. What is the object of it? *A.*—To this question the Westinghouse Air Brake Company reply: "The air only discharges from this small hole when the valve is in full release position. It is intended for an indication to the engineer as to what position the valve is in. As soon as the valve is moved to the running position, the air ceases to waste."

(374) M. U., Buffalo, N. Y., writes: Please give me a practical method to set two lines perfectly square with each other. I want to get them dead true. I have tried as in sketch, but it is unhandy. *A.*—See AMERICAN MACHINIST, page 2, December 18th, 1886, and page 2, December 25th, 1886.

(375) C. F. D., Savannah, Ga., asks: Are there any steam gauges in the market that will register the steam, and show if the steam was allowed to leave the boiler while under banked fire during the night? *A.*—There are such gauges on the market; you can hear of them by inquiring of any dealer in such goods.

(376) A. B., Baltimore, asks: 1. What percentage of wool is there in what is termed a good wool waste—such a quality as is considered best for passenger car journal boxes? *A.*—As far as we can learn, there has not been established a standard of percentage of wool which a good wool waste should contain. Wool waste is not always used for car journal boxes; some roads use cotton waste. 2. What gives to or determines the number of a wood screw? We say a screw is 7/8 of an inch, No. 9. What determines it being No. 9? *A.*—The wood screw gauge, adopted and we believe first established by the American Screw Company, Providence, R. I. See AMERICAN MACHINIST, Question 264, June 18, 1887.

(377) T. W. K., Syracuse, N. Y., writes: Will you kindly answer the following questions: 1. What are the duties of a machinist in the American navy? *A.*—His duties are about the same as that of an engineer in the merchants' service. He will have to stand engine-room or fire-room watches four hours on and eight hours off. He will also have to do the light running repairs. Bad breakdowns are repaired in port. 2. What is the pay of a machinist in the American navy? *A.*—We believe no change in the pay of a first-class machinist has been made. It used to be seventy-six dollars and fifty cents per month, with one ration of nine dollars per month added, making eighty-five dollars and fifty cents per month for first-class mechanics. Lately, second and third grades of mechanics have been added. 3. To whom shall I make the application? *A.*—To the examining engineer on the receiving ship, one of which is generally stationed at each navy yard.

(378) E. J. F., Baltimore, Md., writes: Will you please give the general rules for finding the proper dimensions of a steam engine? For instance: 1. Rule for finding the thickness of metal in cylinder. *A.*—See AMERICAN MACHINIST, page 2, August 22d, 1885. 2. Rule for finding the area of steam pipe. *A.*—AMERICAN MACHINIST, page 6, September 12th, 1885. 3. Rule for finding the area of steam port and exhaust ports. *A.*—AMERICAN MACHINIST, page 5, September 5th, 1885. 4. Rule for finding the width of bridges. *A.*—AMERICAN MACHINIST, page 2, August 22d, 1885. 5. Rule for finding the lap of valve. *A.*—AMERICAN MACHINIST, page 6, November 21st, 1885. 6. Rule for finding the proportions of the eccentric and rod. *A.*—AMERICAN MACHINIST, page 4, September 4th, 1886. 7. Rule for finding the proportions of pistons. *A.*—AMERICAN MACHINIST, page 6, June 11th, 1887, and page 4, June 25th, 1887. Rules for proportioning the other parts to which you refer will soon appear in our columns.

(379) F. G. E., Providence, R. I., writes: 1. Has there ever been a machine devised, to your knowledge, that furnished its own power to keep up motion without loss of either power or motion, save in the natural wear of the machine? *A.*—We have no knowledge of the existence of such a machine, neither do we expect to hear that a machine of this kind will ever be devised. 2. Would a machine be properly a perpetual-motion machine which derived its power through water, considering that water would in time evaporate and the power be lost, allowing a given quantity for power? *A.*—You have not given sufficient data to answer this question; but if you have any idea of inventing or pertecting a perpetual-motion machine, the sooner you throw that idea away the better for you, as thereby you may save a great amount of time and money which could be used for better purposes. To invent a perpetual-motion machine is impossible. 3. I wish to force water a given height through a two-inch pipe. How much more power, if any, is required if I use a two-inch pipe for the lower half and a one-inch pipe for the remaining half? *A.*—Leaving friction out of the calculation, then the power required will be the same in both cases, because the same amount of work is done in the same time in one as is done in the other case. The amount of power required to overcome the friction will depend upon the velocity of the water and the condition of the pipes.

(380) W. L. B., New Haven, Conn., asks: Please give me the correct rule for finding he exact size to bore out a hole, and have it tap uot a full thread. I have always used the following rule: The diameter of bolt, less one and one-half the pitch, will be the diameter of hole before it is tapped. I do not know how near to the exact size will be the diameter obtained by this rule. *A.*—We assume that you wish to know the diameter of the hole in a nut, which, after it is tapped, will have a full American standard thread. To find the diameter of the hole suitable for this thread, we have the following rule: Divide 1.299 by the number of threads per inch, and subtract the quotient from the outside diameter of bolt; the remainder will be the diameter of bolt. This rule is based on the following principle: The diameter of the hole should be equal to the outside diameter of bolt or thread, diminished by twice the depth of the thread. Now, since the depth of the thread is always equal to .6495, multiplied by the pitch, it follows that in order to obtain the diameter of the hole we must diminish the outer diameter of the thread by $.6495 \times 2 \times \text{pitch} = 1.299 \times \text{pitch}$. But the pitch is obtained by dividing one inch by the number of threads per inch; hence the outside diameter must be diminished by 1.299, divided by the number of threads. If we put this rule in the shape of a formula, we have:

$$\text{Diam. of hole} = \text{diam. of bolt} - \frac{1.299}{\text{Number of threads per inch.}}$$

Example: What should be the diameter of the hole in a nut for a 2½ bolt ¼ of an inch pitch?

$$2\tfrac{1}{4} - \frac{1.299}{4} = 2.176 \text{ inches} = \text{diam. of hole,}$$

or say 2 3-16 inches, nearly. If the diameter of hole had been found according to your rule, it would have been 2¼ inches, which is too small. See answer to Question 352, AMERICAN MACHINIST, Aug. 27, 1887.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Wednesday for the ensuing week's issue.

Brass Gears. See Adv., page 16.

Link-Belting.

Send for catalogue of Link-Belting.

Over 50,000,000 feet of Link Belt in use.

Link-Belt Machinery Co., Chicago and N. Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.

AirCompressors,RockDrills. J.Clayton,43 Dey st.,NY

Exhaust Tumbl'g Bbls. Henderson B's., Waterb'y, Ct.

Upright Drills from 20" to 36" inclusive. Currier & Snyder, Worcester, Mass.

For Improved Cooper Stoves, send to Variety Machine Co., Warsaw N. Y.

Light articles built to order by the American Sewing Machine Co., Philadelphia, Pa.

The Best Upright Hammers run by belt are made by W. P. Duncan & Co., Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York, Improved Hydraulic Jacks and Roller Tube Expanders.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Solid Nickel-Seated "Pop" Safety Valves. Consolidated Safety Valve Co., 111 Liberty st., Y. N.

"How to Keep Boilers Clean." A book mailed free, by James E. Hotchkiss, 120 Liberty st., N.Y.

Davis Key-Seating Machines, kept in stock, by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

Injectors, Ejectors, Oil Cups, Sight Feed Lubricators, etc. Arthur Appleton, 45 Cortlandt st., N.Y.

Ice and Refrigerating Machines. 124 built, and all successful. David Boyle, 521 Monroe St., Chicago, Ill.

Selden Packing, for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y

Drawing Materials, all kinds. Get catalogue. Mention this paper. G. S. Woolman, 116 Fulton st., N. Y.

The Improved Tabor Steam Engine Indicator, made and sold by The Ashcroft Mfg. Co., 111 Liberty st., N. Y.

Engine Lathes, Hand Lathes, and other fine tools. Assortment large; prices low. Frasse & Co., 92 Park row, N. Y.

Split Pulleys at low prices, and of same strength and appearance as Whole Pulleys. Yocum & Son's Shafting Works, Drinker st., Philadelphia, Pa.

Quints' Pat. Auto. Steam Engine Governor. Correspondence solicited from mfrs. of Throttle Gov'nr Engines. Leonard & McCoy, 118 Liberty st., N. Y.

Machinists' supplies, brass goods, m'f'rs' supplies, polishing materials, all kinds wire, metals, etc.; in any quantity. Jordan & Gottfried, 208 Canal st., N.Y.

For Best Return Steam Traps, Pressure Regulators, Positive-Acting Pump Govs., Back-Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n.

Curtis Pressure Regulators, Curtis Return Trap, Curtis Damper Regulator. See Sept. 10, p. 15. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

The Holly Manufacturing Company, of Lockport, N. Y., will send, on application, their pamphlet illustrating pumping machinery and reports of duty trials.

Reed's Engineer's Hand-Book to the Local Board Examinations. Eleventh edition revised and enlarged, with 260 diagrams and 36 large plates. 8vo., cloth, $4.50, post-paid. Catalogue of books free. E. & F. N. Spon, 35 Murray st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines, and current practice in testing engines and boilers. Price, $2 post-paid. Published by John Wiley & Sons, 15 Astor Place, New York.

"Binders" for the AMERICAN MACHINIST. Two styles—the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, the full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.

MANUFACTURES

Sexten & Hunter are building a planing mill at Greenville, Tenn.

The citizens of Guthrie Center, Iowa, are thinking of water-works.

The plans for water-works are being prepared at Manitowoc, Wis.

Senator Harkinson's lead-pipe works at Denver, Col., will be enlarged.

James Sutherland & Co. will build a planing mill at Nashville, Tenn.

Mackintosh, Hemphill & Co., Pittsburgh, Pa., will build a new steel foundry.

The furniture factory of A. W. Wilson & Bro., at Morganton, N. C., will be rebuilt.

A wood-working establishment will be built at Greenville, Miss., by H. Sommers & Sons.

The Cowan Woolen Company, Lewiston, Me., has recently begun business. Capital stock, $75,000.

The Weber Wagon Company, Chicago, Ill., are rebuilding their factory, recently destroyed by fire.

The Union Machine Works, Little Rock, Ark., are being enlarged and a foundry and boiler shop erected.

The Mansfield Pressed Brick Manufacturing Company, Mansfield, Ohio, have recently begun business.

The Abbeville Land and Improvement Co. are interested in building up manufactures at Abbeville, Ga.

The planing mill and box factory of W. H. Moxley & Co., Macon, Ga., lately destroyed by fire, will be rebuilt.

The Golden Belt Manufacturing Company will establish works for making bags, sacks, shirts, etc., at Durham, N. C.

Lewis Krulewitch will build a six-story brick workshop on Madison street and Birmingham street, New York city.

The Little Falls Improvement Company has been incorporated at Louisville, Ky. They expect to improve water-powers.

The Big Falls Cotton Mills has been incorporated at Big Falls, N. C. The company propose also to operate saw and grist mills.

A company, under the title of the Houston Building Company, are building shops at Houston, Tex., in which to build portable houses.

The North Star Iron Works, Minneapolis, will move from their present quarters for the purpose of securing room for enlargement.

The Stevenson Land and Improvement Company has been established at Stevenson, Ala., to establish, manufacture and work mines.

The citizens of Glenwood Springs, Col., are to vote on the question of building water-works. It is thought the vote will be favorable to building.

The Link Belt Machinery Co., Chicago, Ill., are putting in new machinery as they can make room for it, to increase the capacity of their works.

Extensive additions are being made to the rubber works at Millville, Mass. When the additions are completed about 300 more hands will be employed.

The Tallapoosa Land, Mining and Manufacturing Company are interested in building a rolling mill, a furniture factory and a cotton factory at Tallapoosa, Ga.

The types made us say last week that the machine works of Geo. R. Lombard & Co., Augusta, Fla., recently burned, will be rebuilt. Augusta., Ga., was meant.

Edward A. Oldham, of Anniston, Ala., is desirous of corresponding with a practical wagon maker, with a view to establishing the manufacture of road carts there.

Fred. Balcom, general manager of the Harrisburg (Pa.) Cold Storage Company, has just completed arrangements with leading citizens of Waldo, Fla., for the immediate construction of a plant in that town.

It is announced that the St. Paul, Minneapolis and Manitoba Railroad has purchased between 300 and 400 acres at St. Cloud, Minn., and will locate at that place its main car shops and stock yards for the entire system.

At a special election in Sault Ste. Marie, Mich., on the proposition to bond the city for $12,500, $10,000 to be used for the extension of the water-works and the remainder to build an engine house, the town gave a "yes" majority of 78.

C. W. Coles, of MacGregor, Iowa, and Capt. I. A. Fuller, of Lake Pepin, Minn., are associated in important discoveries of hematite iron ore, said to have been made near the latter place. A company will be formed to develop the ore beds.

Mayor Hill, of Northampton, Mass., acting for the Hill & Martin Cash Carrier Co., recently bought the wood-working mill of the Florence Machine Co. and will put in machinery at once to begin the manufacture of his carriers in it by October 1.

A. Mugford, wood engraver and printer, Hartford, Conn., sends us the July number of the *Manufacturers' Exchange*. It is in reality a catalogue containing specimen engravings executed by him, very finely printed on excellent paper.

We have received from H. D. Penney, New Gloucester, Me., an illustrated catalogue of centrifugal pumps, both horizontal and vertical, sold by him. The catalogue gives information as to setting up and operating the pumps, and other convenient information.

The Valley Iron Works, Williamsport, Pa., are putting on the market machines for making wire nails, the invention of S. S. Babbitt, their foreman. The concern expect to engage extensively in the manufacture of these machines, and to this end will considerably enlarge their works.

Geo. W. Smith writes us from Winona, Minn.: "On Sept. 1st I will start the shops at Wabasha, Minn., to be known as the Wabasha Machine and Foundry Company—Geo. W. Smith, manager—doing a general machine and foundry business. In the future will make some specialties."

Fiske, Coleman & Co., 62 Federal street, Boston, have been appointed New England agents for the Evansville Spar Mining Company, Evansville, Ind. They will carry a stock of fluor spar on hand for the accommodation of foundrymen, iron making, and other industrial establishments requiring the use of this mineral as a flux.

According to the *Journal of Commerce* of that city, a company is now organizing in Denver, Col., for the manufacture of mica, which is said to abound in that State, for decorating and lubricating uses. First-class machinery will be arranged for. J. T. Cornforth and Ira Pendleton are individuals mentioned as interested in mica mining.

The Western Forge and Rolling Mills, East St. Louis, Mo., are preparing for the manufacture of railroad links and pins, in addition to their regular specialties. The outlay involved in the erection and equipment of the necessary addition will not fall far short of $25,000. When these improvements are completed, the company's working force and pay roll will be largely increased.—*Age of Steel.*

The Wason Company, of Springfield, Mass., are building eight cars which will be used on the State roads of Chili. These cars are different from ordinary coaches in the decorations and in the windows, which are each four feet wide: Between all windows is a match safe, for every one in Chili smokes. Four of the cars will be shipped during September. Each of the Chilian cars will cost $12,000.

The Denver *Journal of Commerce* reports the starting of new industrial establishments in Colorado as follows: The Colorado Glass Works Co., capital stock $50,000, at Golden; Geo. B. Koyle, formerly of Kansas City, Mo., woolen mill at Fort Collins; and the Grand Junction Milling Company, at Grand Junction, with capital stock of $25,000—David Roberts, Henry H. Dale and Albert A. Miller, directors.

A company, known as the East Chicago Steel Company, composed of Wheeling capitalists, has leased the Bessemer steel plant at Hammond, Ind. Spalding Wallace is president of the company; Alexander Glass, secretary; and Walker Peterson, manager. The gentlemen connected with the new company are for the most part well-known iron and steel manufacturers. Operations will be commenced at once.

The *Industrial Journal* says of Milltown, Me.: "Any concern that is in quest of water-power and a favorable chance to manufacture any line of goods adapted to this locality, such as paper or woodenware, would find here one of the best locations for such a business in the State. One mile and a half of railroad will take the product of their mills direct to the point of shipping; the railroad is already here, and convenient to the proposed site."

In a previous issue we noticed the organization of the Waterhouse Electric and Manufacturing Company, of Hartford, Conn. Being himself an accomplished mechanic, Mr. A. G. Waterhouse, in forming a company to introduce his system of electric lighting, was able to enlist several gentlemen of high standing in Hartford machinery establishments in his enterprise, including Messrs. Francis A. Pratt, Charles E. Billings, Geo. M. Bond, Chas. P. Howard and Asa S. Cook. The company are now well established at their works at Hartford, and are well provided with facilities for pushing the business.

Although Minneapolis has quite a number of good machine shops that are capable of doing first-class work, there are none able to do heavy work except at a disadvantage. Every day the demand for large tools that can handle any work becomes more and more urgent. It is not an uncommon thing for heavy work that might be done here to go elsewhere on account of this very want. Boring mills, heavy planers, punching and shearing machines, special pulley lathes, and radial drills are the ones most lacking. There is another class of machines, embracing milling machines, gear cutters, turret head lathes, shapers, etc., which are seldom met with in this section. There is no doubt but that a good shop, well supplied with the tools here indicated, could do a first-class paying business in a very short time. It is not probable that Minneapolis will long want such an establishment, as the growing demands are already causing the present shops to enlarge their capacity. —*Wood and Iron.*

Machinists' Supplies and Iron.

NEW YORK, Sept. 1, 1887.

Iron—There is no change to note in the market for American pig, the demand being almost entirely of a hand-to-mouth character. It has seemed at times as if prices must rule in buyers' favor, but generally hold er s are fir

Scotch Pig—Scotch brands have been in fair demand. We quote Coltness, $22.50 to $23; Glengarnock, $21.25 to $21.75; Gartsherrie, $21.25 to $21.75; Summerlee, $22.25 to $22.75; Eglinton, $20.50; Langloan, $21 to $21.50; Dalmellington, $20.50 to $21.

Lead—There have been no transactions of any account. The asking price is 4.65c, with 4.60c. offered.

Antimony—Hallett's, 8¾c; Cookson's, 9c.

Copper—The market is quiet, with no speculative tendency apparent. Spot lots have been offered at 10.80c., with 10.60c. bid.

Spelter—Refined, 5¾c. to 6c.

Tin—Jobbing lots of Banca have sold at 24c.; Straits and Malacca, 23.30c.

WANTED

"Situation and Help" Advertisements only inserted under this head. Rate, 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Wednesday morning for the ensuing week's issue.

Situation in machine shop, by mechanical draftsman and designer. Box 54, AM. MACHINIST.

Situation wanted by a well-posted designer and machine draftsman. Address T., AM. MACHINIST.

Mechanical draftsman wants position; has college education and several years' experience; correspond with A. D., AM. MACHINIST.

Wanted situation; shop experienced designer of general wood-working machines; late with Glen Cove Mach. Co. G. Baum, Station G., B'klyn, N. Y.

Wanted—A first-class man as foreman machinist in a general jobbing shop. Address Fulton Iron Works, St. Louis, Mo., stating age, experience, and where last employed.

Wanted—Four or five first-class machinists to run twenty and twenty-four inch engine lathes on fine work in brass and iron; steady work; state age and wages expected. Merwin McKaig, Cumberland, Md.

A first-class mechanical engineer and draftsman, with theoretical knowledge and extensive practical experience in designing, estimating and constructing, is open for an engagement. Address D. E. C., P. O. Box 568, Chicago, Ill.

Mechanical engineer and practical machinist solicits correspondence from parties wanting mechanical supt. or foreman; large experience in all classes of marine and stationary engines, mining, mill and general machinery. M. E. M., AM. MACH.

✝ MISCELLANEOUS WANTS. ✝

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Crescent Boiler Tube Expander; second to none; price in reach of all. Crescent Mfg. Co., Cleveland, O.

The Crescent Link Belt Coupling; something new; sample free. Crescent Mfg. Co., Cleveland, O.

Light mach'y of all kinds built at short notice Edmund Mills, 8 Dey st., Jersey City Heights, N. J.

Stationary boat engines, boilers, best, cheapest, 1 to 10 H. P. Washburn Engine Co., Medina, Ohio.

Special tools and machines for mfg. designed and built to order; mechanical and Patent Office drawings. I. A. Weston & Co., Syracuse, N. Y.

An experienced teacher and mechanic desires engagement to teach mech'l drawing; tools, wood and iron workshop practice. "Honest Worker," AM. MACHINIST.

A. C. Christensen, 26 Church st., N. Y., mech. and hydraulic engineer, late chf. draftsman at H. R. Worthington; mechanical and patent drawings; patents of natural gas and water meters for sale.

Wanted—A second-hand shaping machine, modern make, in good cond tion, medium small size. Address, with full description and price, Eastman Freight Car Heater Co., 50 State st., Boston, Mass.

If you are troubled with scale in your boiler, whether from lime, sulphur, iron, salt or other mineral or corrosive water, send for circular of Petroleum Resolvent, adopted on one hundred railroads. Contains neither alkali or acid, and costs but ten cents a week for the largest locomotive boiler. Pittsburgh Boiler Scale Resolvent Co., Pittsburgh, Pa.

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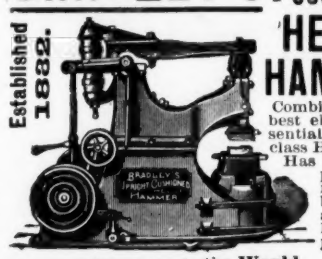

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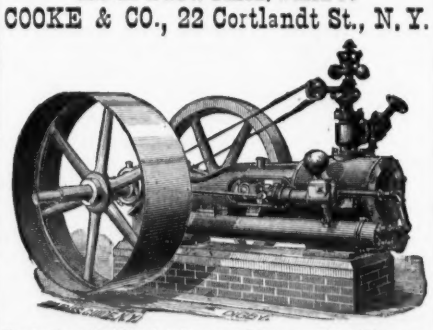

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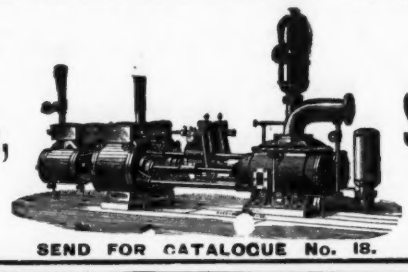

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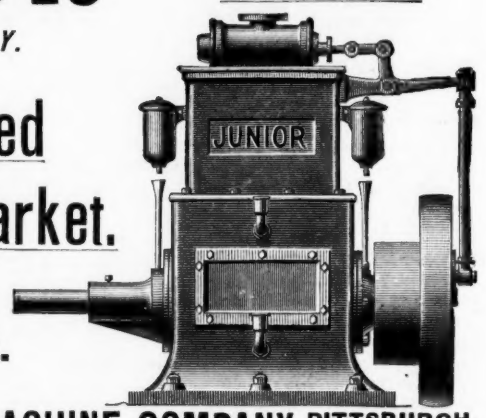

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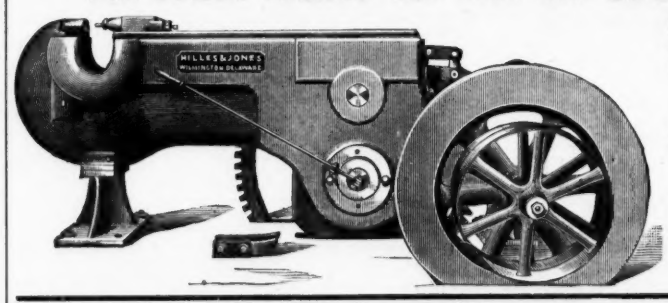

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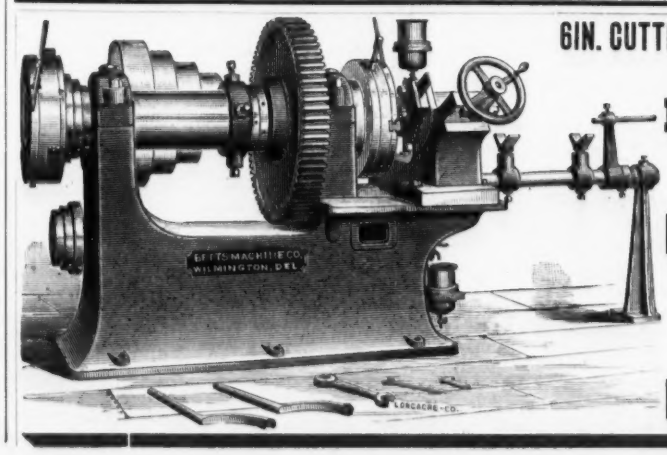

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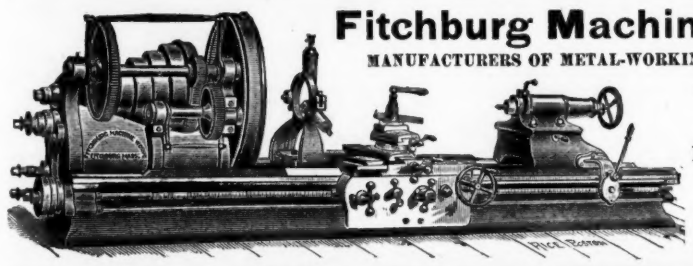

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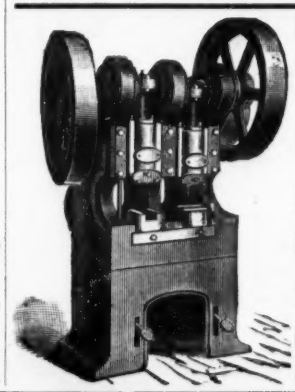

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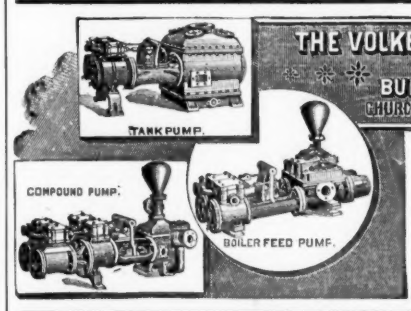

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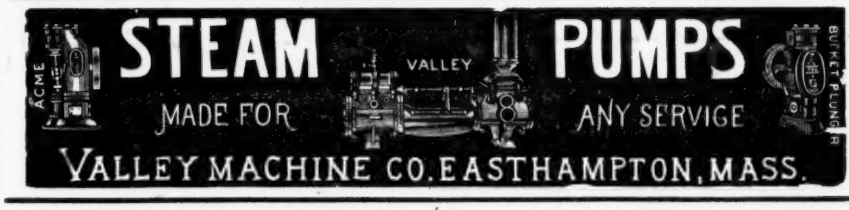

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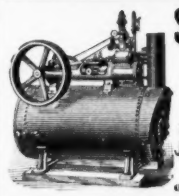

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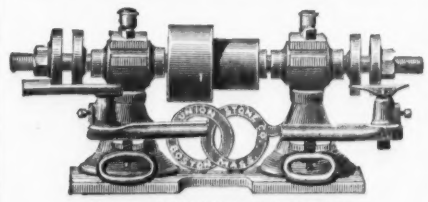

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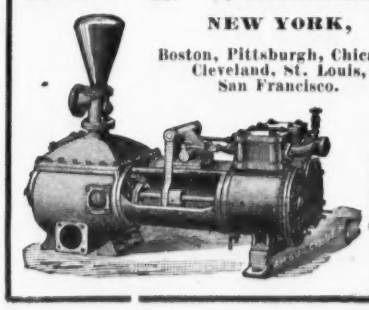

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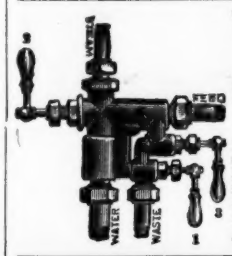

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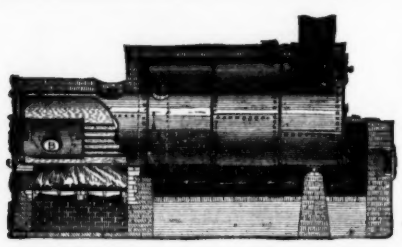

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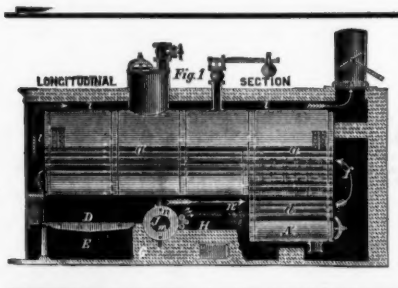

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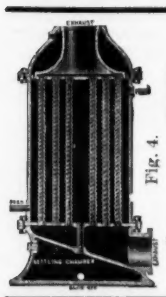

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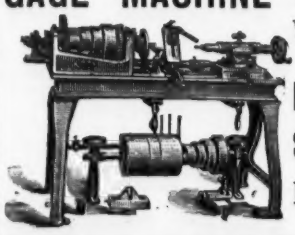

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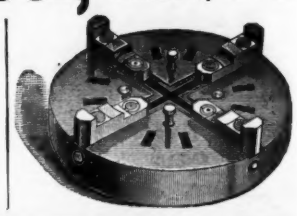

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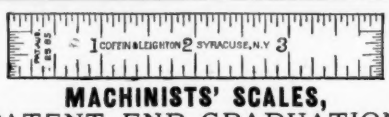

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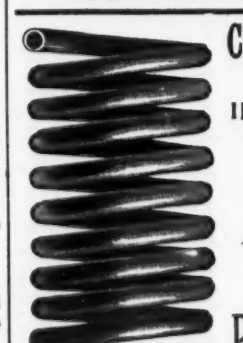

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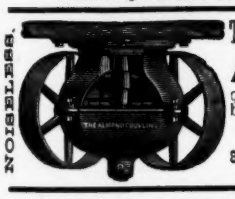

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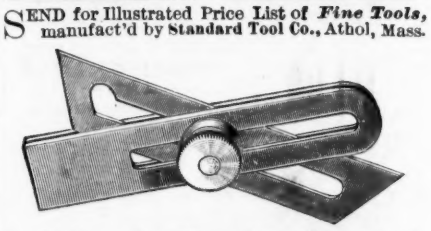

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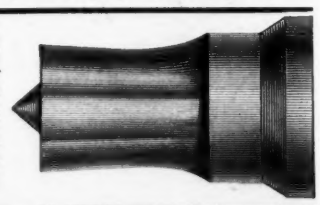

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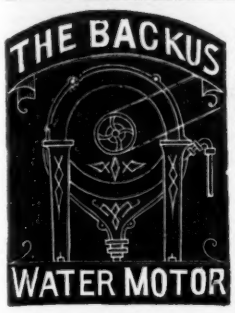

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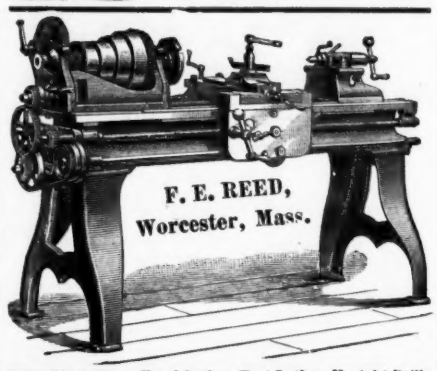

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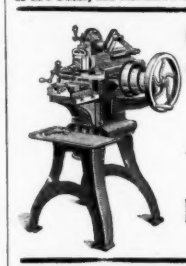

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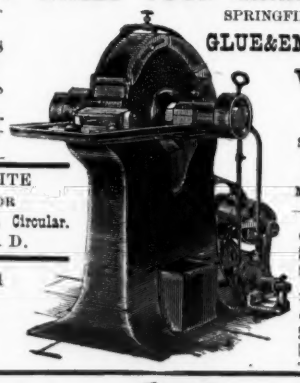

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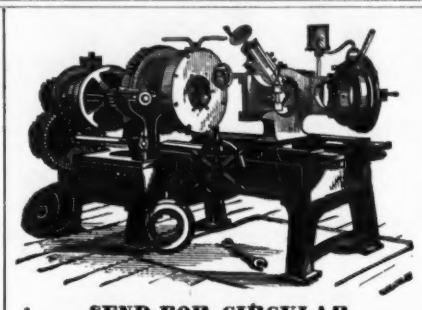

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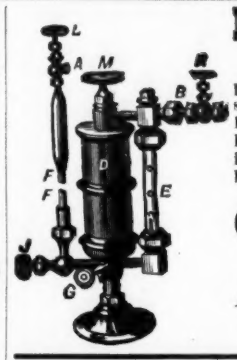

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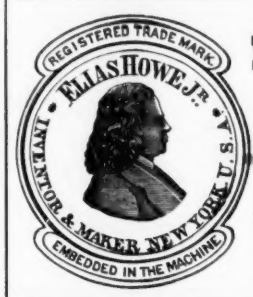

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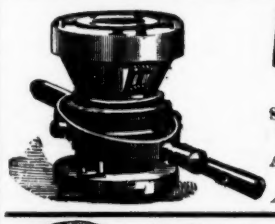

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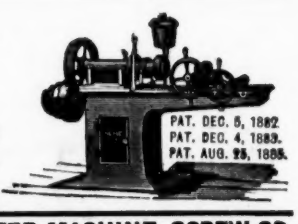

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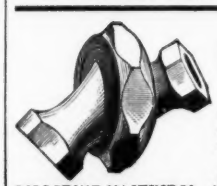

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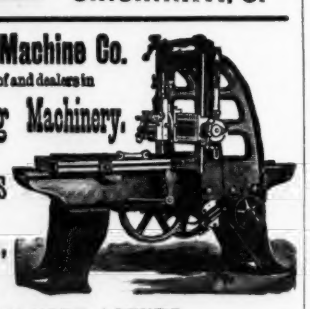

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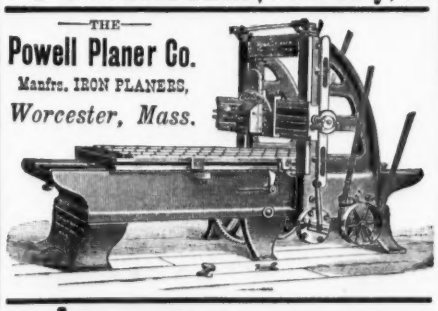

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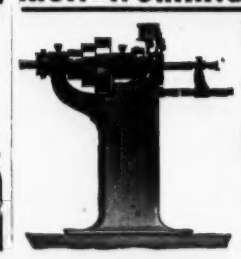

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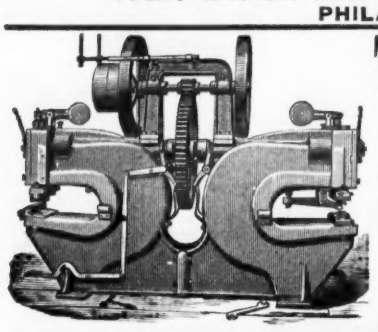

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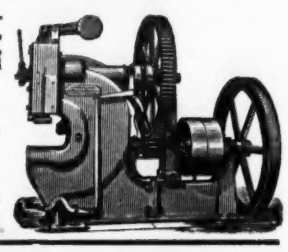

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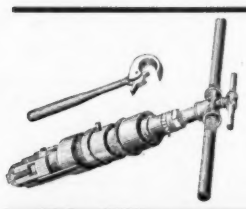

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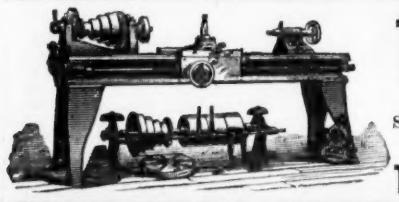

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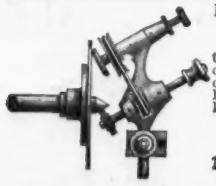

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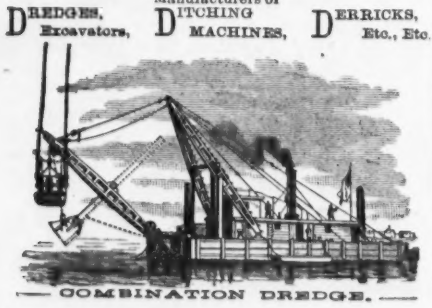

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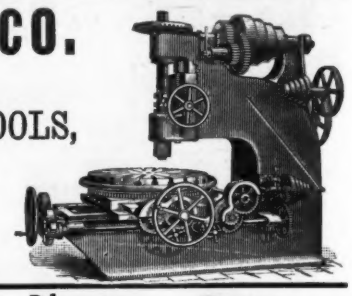

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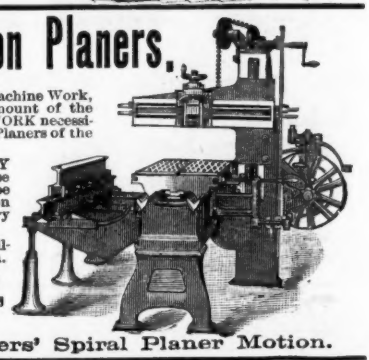

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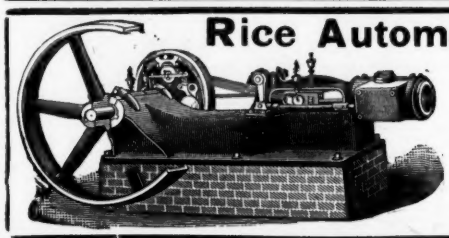

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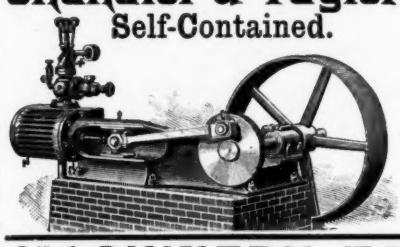

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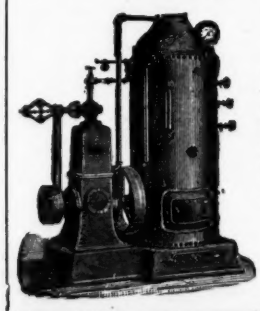

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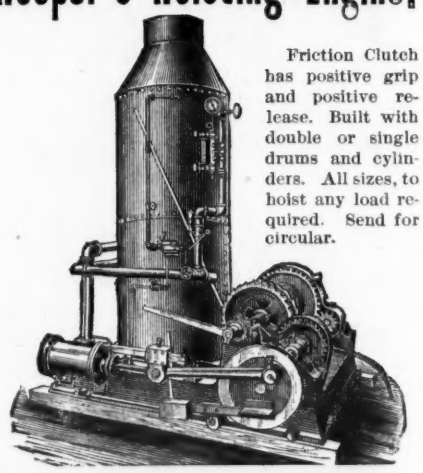

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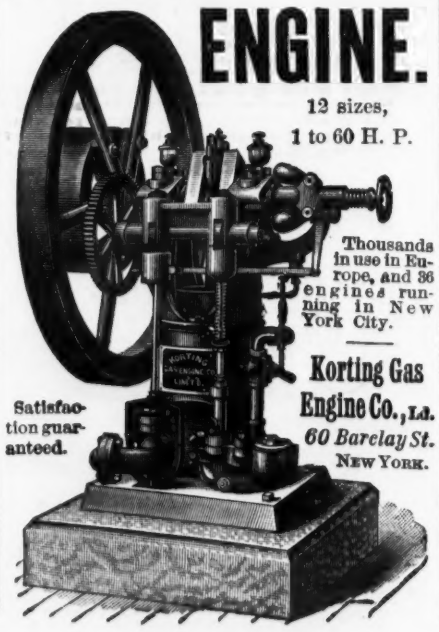

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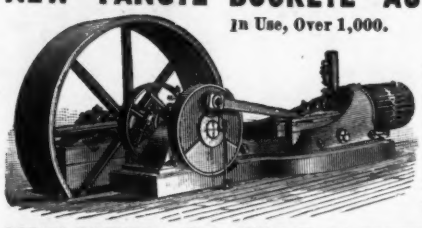

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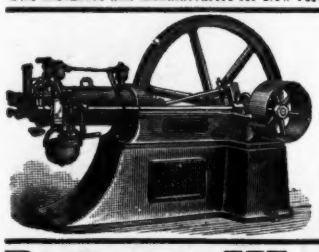

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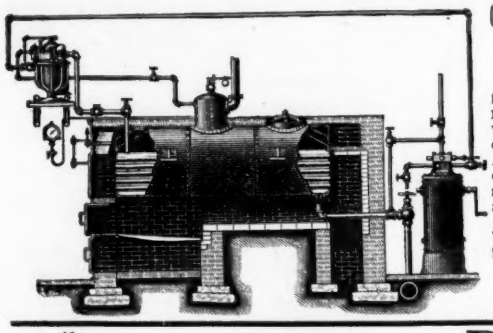

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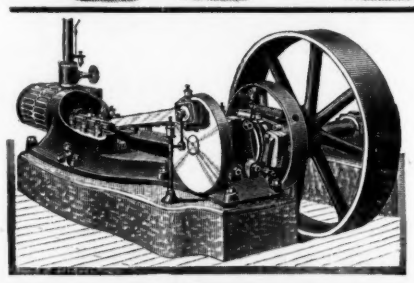

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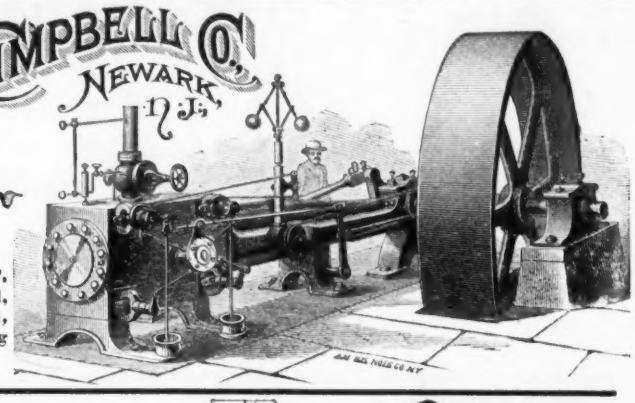

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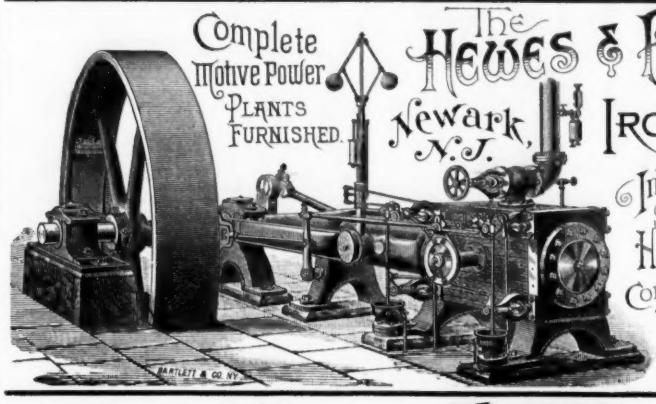

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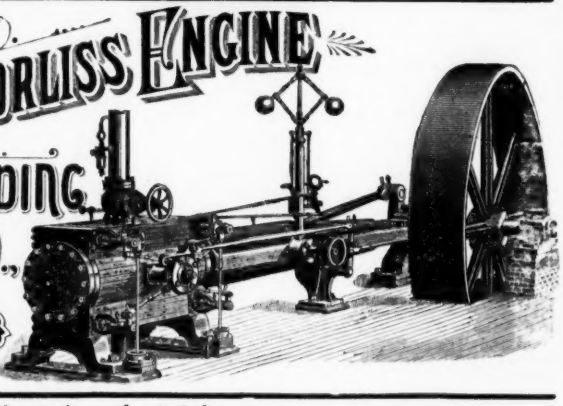

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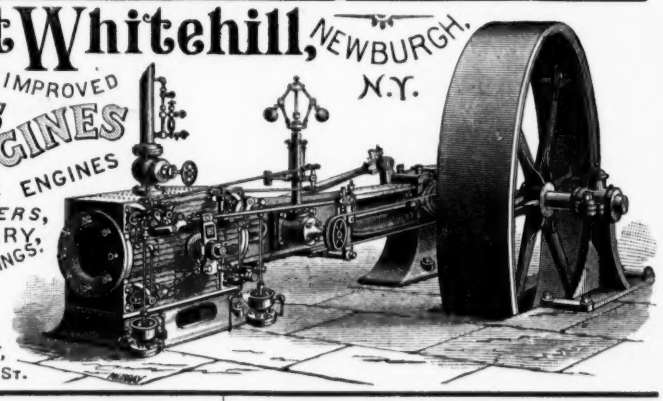

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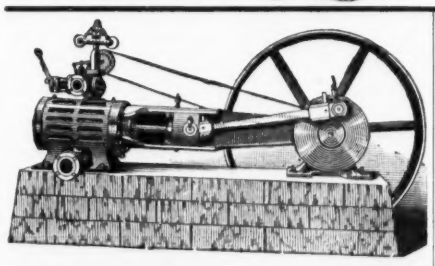

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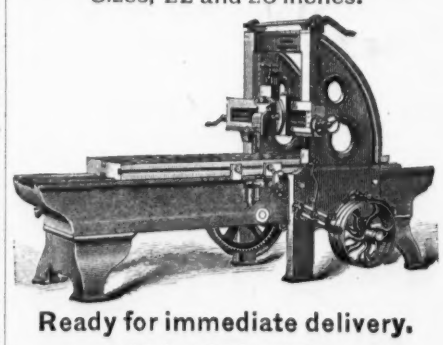

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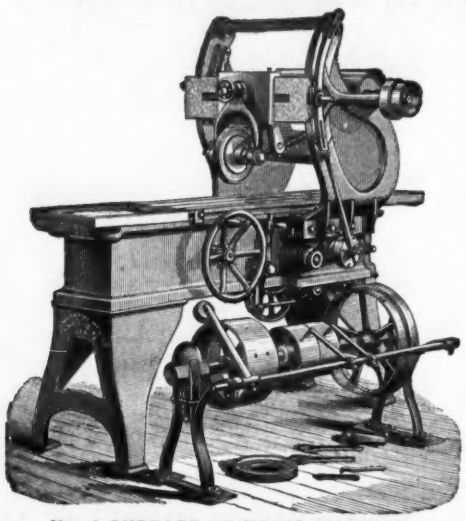

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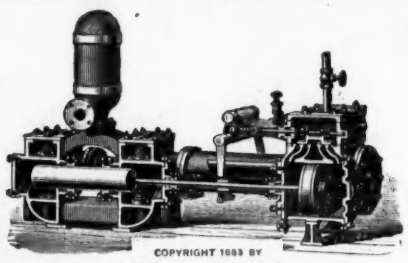

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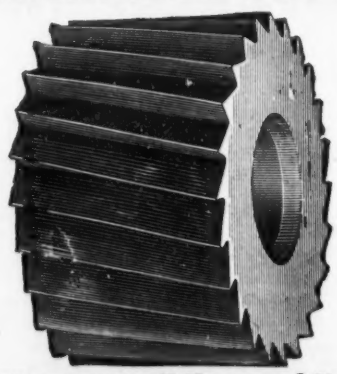

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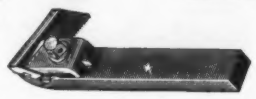

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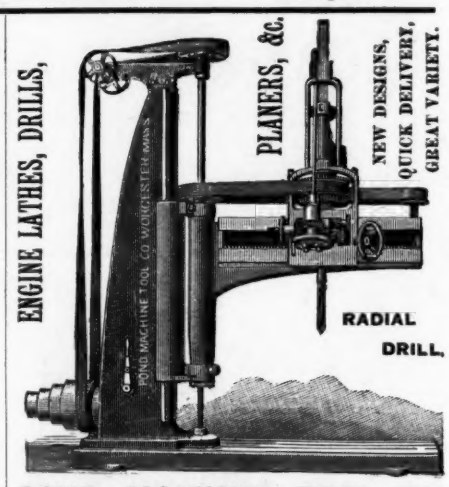

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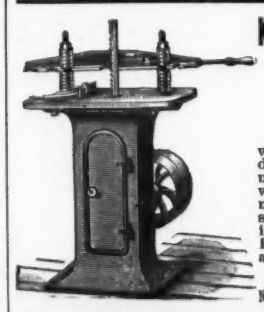

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